



Custom Milled PCB Pins

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<https://learn.adafruit.com/custom-milled-pcb-pins>

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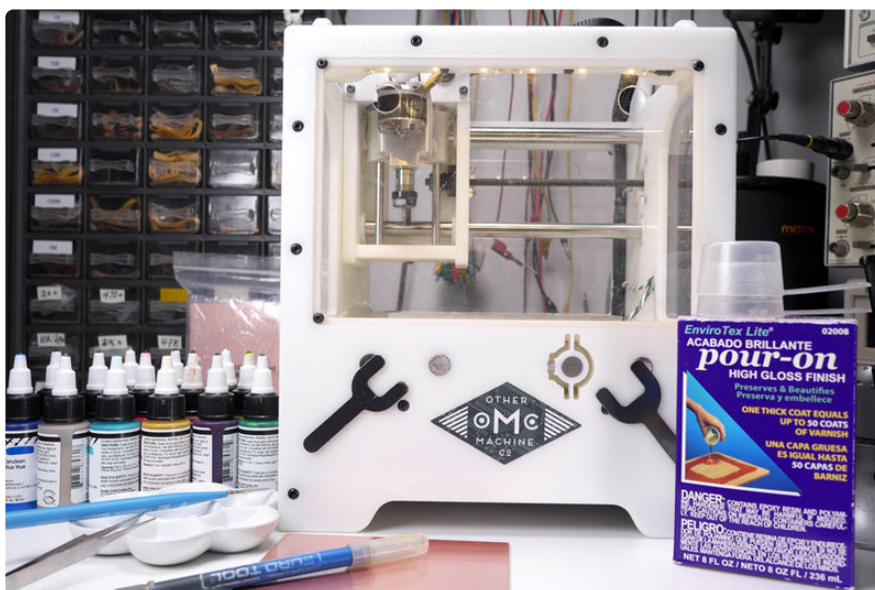
Overview



Milling machines are great for prototyping your own PCBs, but they can also be used for making excellent decorative art and wearables. In this guide, I'll show you my process for using a milling machine to create custom, hand painted, resin glazed pins using copper PCB material.

This project assumes you are familiar with vector design software and the CNC milling process in general.

Tools & Materials



Required:

- Milling machine
- 1/32" flat end mill bit
- Double-sided copper clad FR-1 board
- Double-sided tape
- Pin posts and clasps
- Acrylic paint or gouache
- Fine tipped brush
- Resin glaze (such as Envirotex Lite)
- Mixing cup and stirrer for resin
- [Solder tack flux \(http://adafru.it/2667\)](http://adafru.it/2667)
- [Lead-free solder \(http://adafru.it/1930\)](http://adafru.it/1930)
- [Soldering iron \(http://adafru.it/180\)](http://adafru.it/180)
- Vector design software (Adobe Illustrator, Inkscape, etc.)
- Small tabletop vise (such as [Panavise Jr. \(http://adafru.it/151\)](http://adafru.it/151))
- Alcohol & cotton swabs

Optional:

- Latex/nitrile/vinyl gloves
- 1/16" flat end mill bit
- Plastic or metal scraper/putty knife
- Razor/X-acto blade
- Paint palette/dish
- Plastic straw
- Hair dryer

Design

First off, we'll need a design for our pin. The milling software we'll be using can import vector art in **SVG format**. Here are some common applications you can use to create SVG files:

- [Adobe Illustrator \(https://adafru.it/CiB\)](https://adafru.it/CiB) (macOS, Windows)
- [Inkscape \(https://adafru.it/CiC\)](https://adafru.it/CiC) (macOS, Windows, Linux)
- [Sketch \(https://adafru.it/CiD\)](https://adafru.it/CiD) (macOS)
- [Corel Draw \(https://adafru.it/CiE\)](https://adafru.it/CiE) (Windows)

For this guide I'll be using Adobe Illustrator CS6.

Create Your Design

Your final design should use only one fill color and no strokes. The color-filled shapes will translate to copper in your finished pin, while areas left transparent will be engraved to a depth we specify in the milling software.

Create your design as you see fit, using separate shapes, strokes, etc - just keep it limited to one color on a transparent background. In my bird example below, I have a variety of paths and strokes which form my final black-on-transparent image:

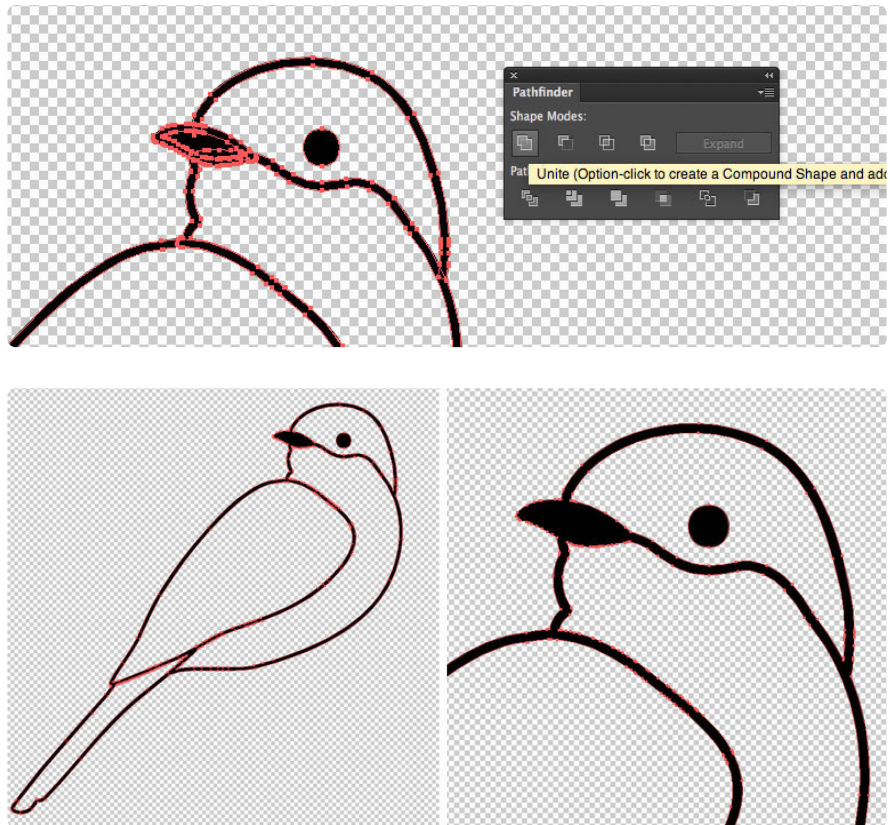


Merge Shapes

Before saving a final version for milling, I'll need to merge those separate paths into a single filled shape, but first, the stroked paths need to be converted into filled shapes. In Illustrator, you can use the **Outline Stroke** command to turn any strokes into actual paths:



Once the strokes are converted, merge all the filled shapes together using Illustrator's **Pathfinder** menu by choosing the **Unite** tool:



Our final vector art is one solid shape on a transparent background. Be sure to check for any stray paths or points and delete them.

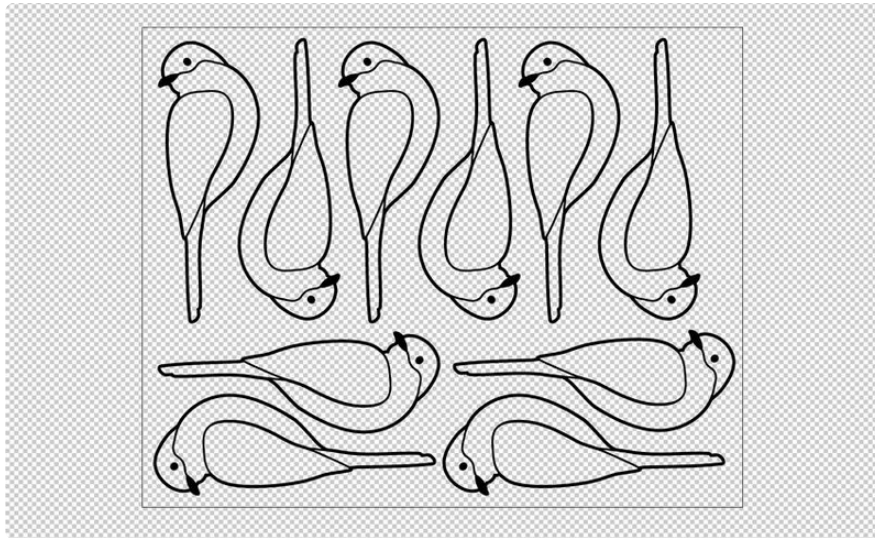
Check Scale

Setting the scale of your design to an appropriate size for milling may take a little trial and error. Try skipping ahead to the **Save as SVG** step below and import the file into your milling software. Set your milling software to generate a preview using a **1/32"** bit.

This preview of the final product will give you an idea what level of detail and scale will work best. Reopen your SVG file and edit the art to accommodate those new constraints.

Optional: Tiling

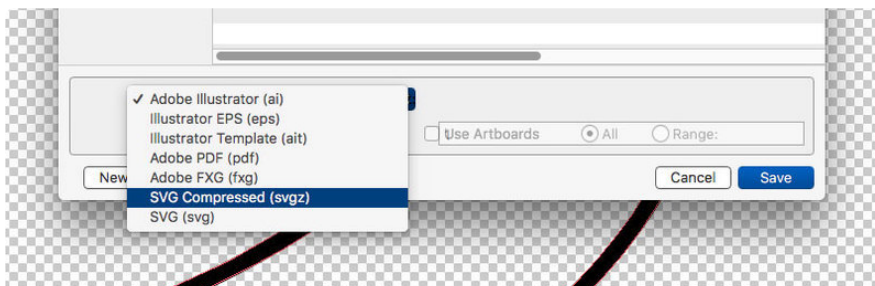
To keep things simple for this tutorial, I'll only be milling a single bird - but if you'd like to make multiple pins you can duplicate your art to fit more on one piece of material.



Update your vector file's artboard to represent the actual size of the copper-clad board (**width = 127mm, height = 101.6mm**). Create multiple clones of your original art and rotate each one to maximize the number of instances you can fit on your board.

Note: Remember to leave clearance between each instance and the edge of the board as seen above!

Save as SVG



Once everything looks nice and clean, **save the image in SVG format**. We'll import this file into the milling software.

Milling



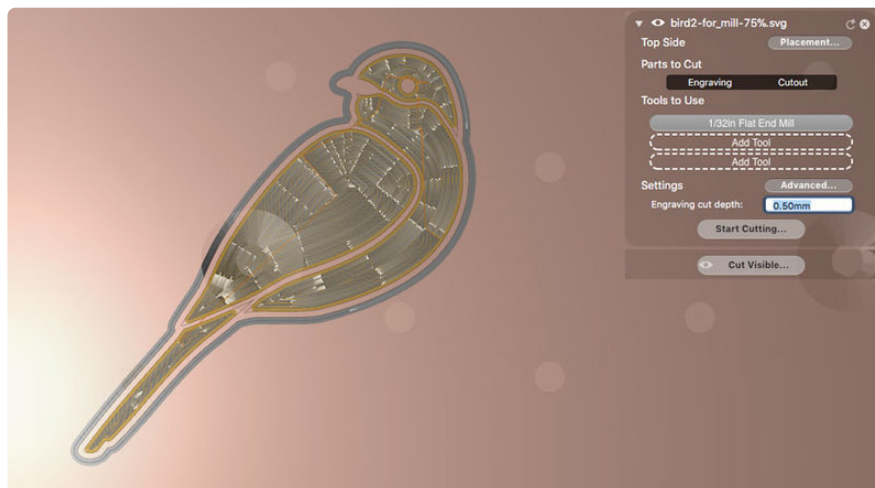
Launch your milling control software and start a new session. For this guide I'm using the **Otherplan** app to control my Othermill machine.

To accommodate our double-sided copper clad board, specify the material as **Double-Sided FR-1**. Doing so should give you the following dimensions:

- X: 127mm
- Y: 101.6mm
- Z: 1.64mm

Set the material's **origin** to X:0, Y:0, Z:0.

Import your art



Note that I'll be milling a single pin for this guide, but you likely want to add more to make use of the entire copper board.

Import the vector file you created and set the following variables for it:

- Invert within cutout
- Engraving depth: 0.5mm
- 1/32" flat end mill bit

The "**invert within cutout**" setting (found in Otherplan's "Advanced" settings) will make the milling software use the empty/transparent areas for engraving, and the filled/black areas as copper to be left untouched.

Using an **engraving depth** of **0.5mm** will make it easier to keep paint within the engraved and away from the raised copper.

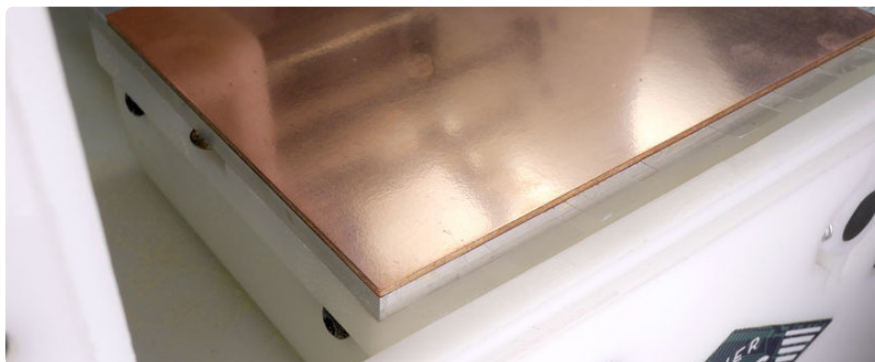
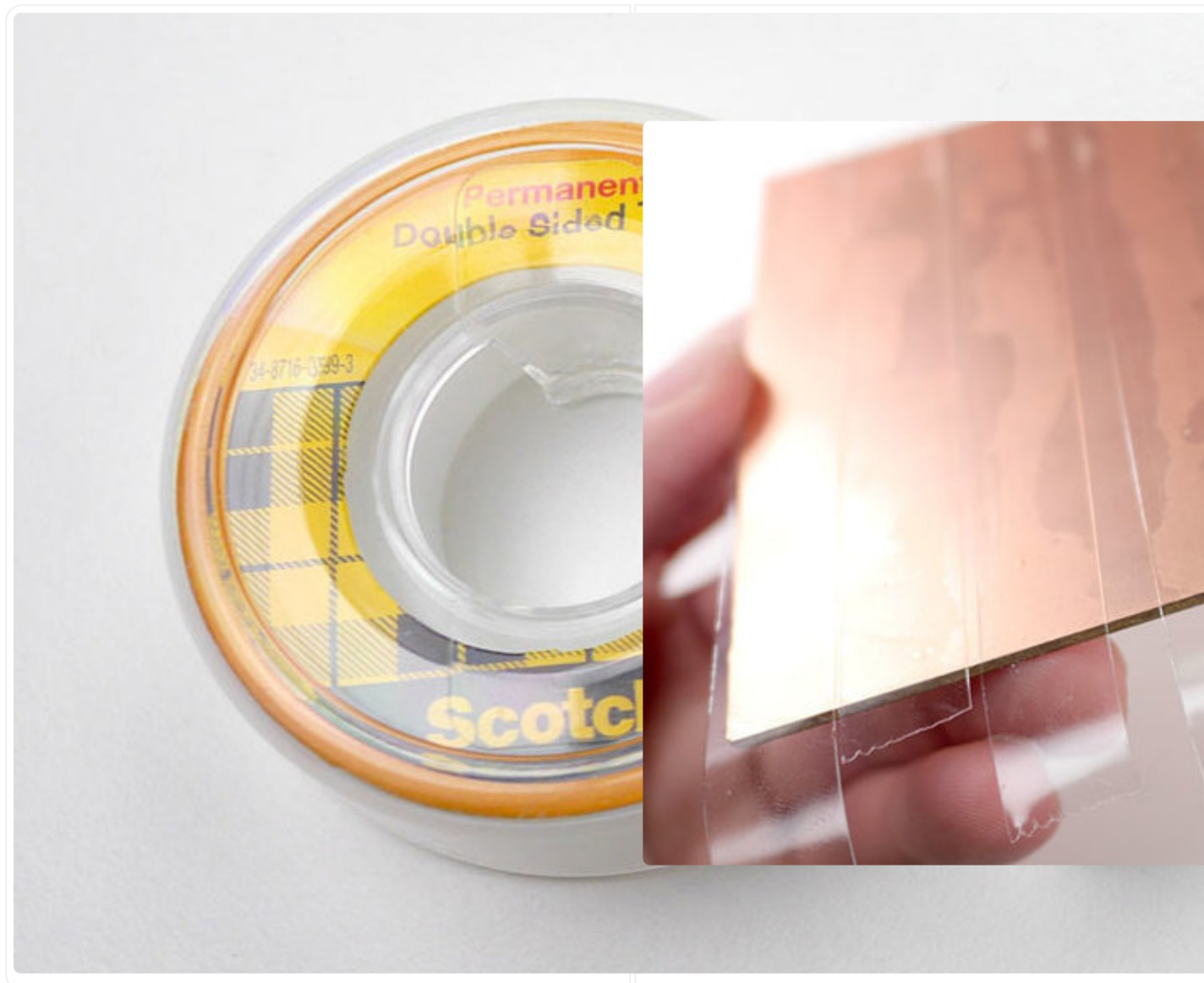
I've found that **1/32"** is the smallest size bit which holds up well to repeated use. Smaller bits tend to break too often, and larger bits don't allow for enough detail on pins.

One Bit or Two?



You can mill your design using multiple sized bits for increased efficiency and speed or use a single small bit for simplicity. Depending on your machine's accuracy, using a single bit can produce cleaner results but takes considerably longer than a multi-bit approach.

The Actual Milling

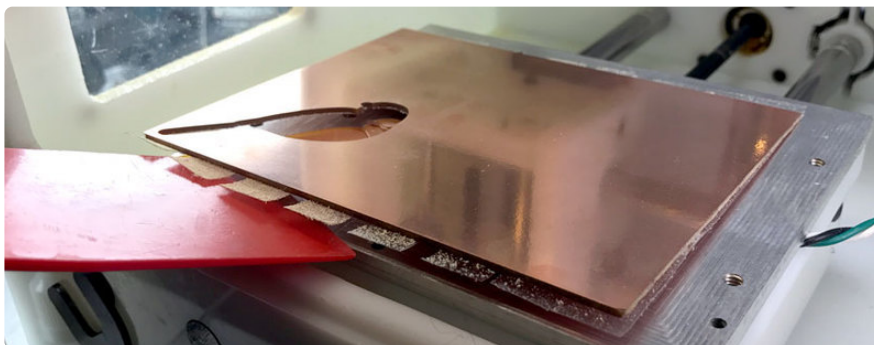


Use strips of double-sided tape to secure the copper board to your mill's bed. Be sure the the board is mounted squarely with the left and front edges of the bed.

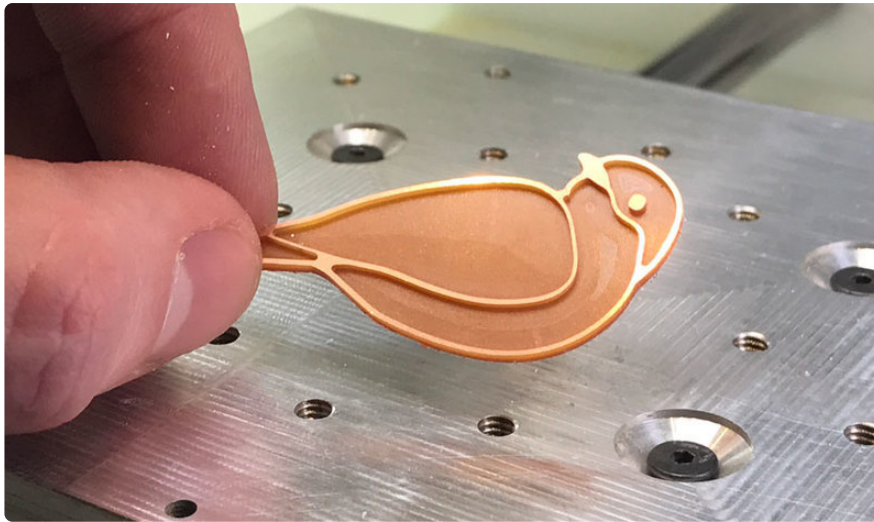


Connect power and USB to your milling machine and begin the milling process from the software UI.

Milling Complete

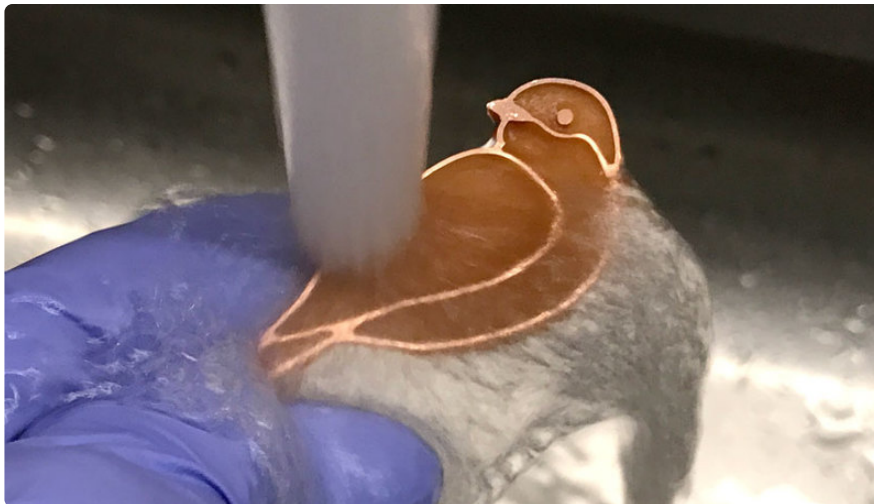


Once the mill is complete, use a **vacuum** to remove excess dust and peel the board from the bed with a **flat scraper** or putty knife.



Peel off your finished piece and **remove any remaining tape** from the back. Inspect the piece for stray copper burrs and remove them with tweezers or a blade.

Painting



Run water over the finished piece to remove any remaining dust. Allow it to dry thoroughly before you begin painting.



Many different types of paint can be used to fill your pins engraved areas. My personal preference is **Golden High Flow Acrylic** as it doesn't need to be thinned with water before application. Alternatively, gouache paint offers some advantages with saturation and opacity – but it can create issues with viscosity and air bubbles.

For the level of detail in my bird design, a **2/0 "round" brush** will work fine. For pieces with finer detail, I'll often use a **20/0 "spotter petite" brush**.

Paint Your Design



Fill the engraved areas of your design thoroughly with paint, making sure to cleanly fill each shape's corners and edges. The High Flow acrylic paint will flatten a lot as it dries - fill each engraved shape up like a small pool/puddle to avoid the board's FR-1 material from showing through.



Once painting is complete, allow your piece to dry thoroughly in a dust-free area. I place mine in a resealable food container with the lid left ajar to provide some air circulation.

Glazing

For coating my pins, I use a 2-part epoxy resin called **Envirotex Lite**. It has a nice thick viscosity which creates an eye-catching, resilient finish - but can sometimes create small bubbles which can be difficult to remove. If you want to avoid bubbles at all costs, you can use a less viscous resin to coat your pins.



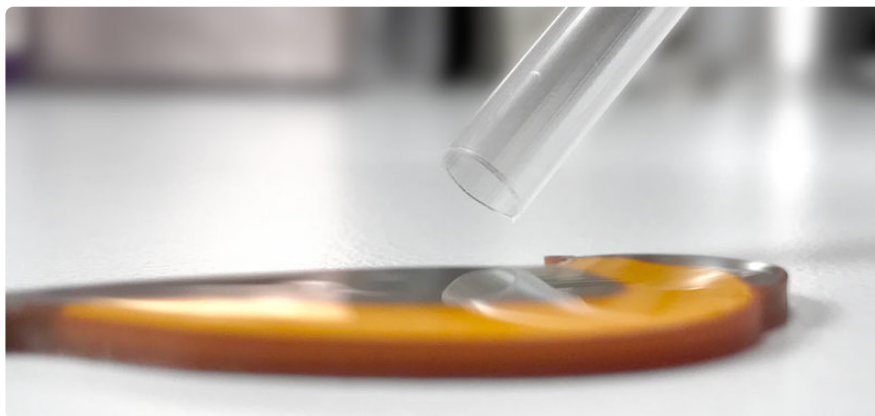
Thoroughly mix your resin per the included instructions. Once the resin appears crystal clear and fully mixed, pour it into another container to avoid using any unmixed portions.



Use a tongue depressor (aka "craft stick") to **drip a puddle of resin** onto the center of your pin.

Gently drag the resin out to the edges of your piece, adding more as needed. Ensure the resin flows out to entire edge of copper. A thicker coating will create a more pleasing 'liquid' aesthetic, but can be difficult to remove bubbles from.

Removing Bubbles



Bubbles in the applied resin coating can often be removed, but you'll need to act quickly before the resin begins to cure. I use two techniques for de-bubbling resin glaze:

- **Air Pressure:** Using a straw, blow a quick blast of air directly at the bubble. This can quickly displace the resin and pop the bubble.

- **Heat:** Briefly pass a hair dryer on low heat over the resin surface. Be careful not to hold the dryer over the surface for too long or the resin will begin to harden and create even more bubbles in the process.

If you mess up your glazing you can start over by removing both the paint and resin with acetone.

Drying



Once your resin is applied, allow it to cure undisturbed on a **flat, level** surface for **24hrs**. To protect the resin from airborne dust, loosely cover your piece with a bowl or plastic food container as a sort of 'drying canopy'.

Mounting

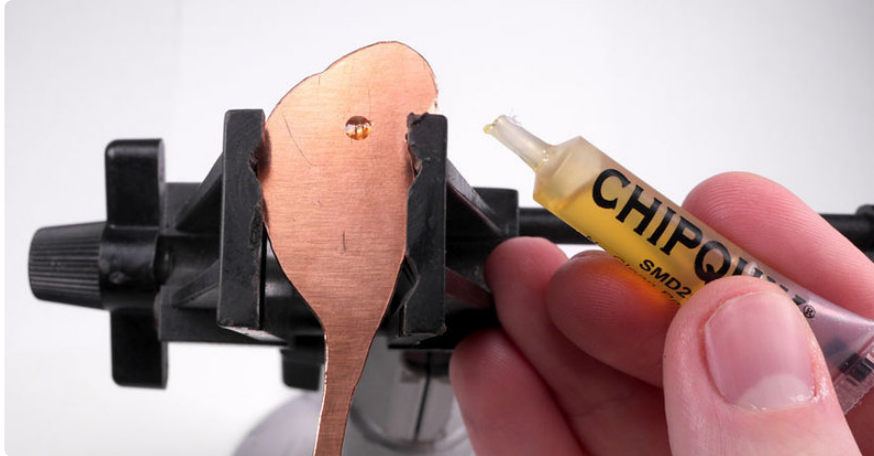


Once the resin has thoroughly dried, we can mount the pin posts to the back of the piece. I use **butterfly clutch tie tack/pin backs** of **8mm** length.

Secure your piece using a small **hobby vice**. Place a small bead of **tack flux** on the spot you wish to mount your pin post.

Soldering

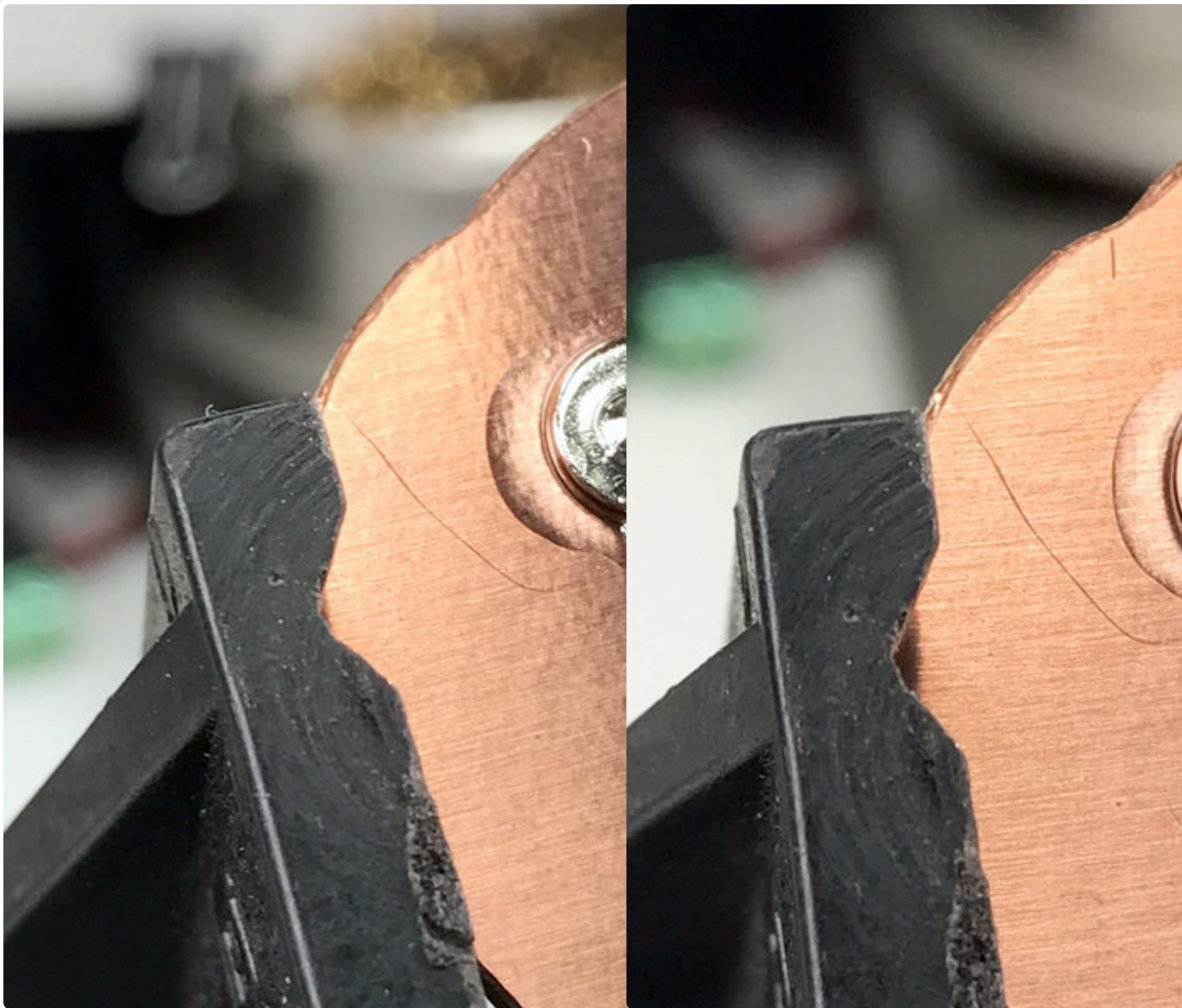
While soldering, do not keep the iron pressed against the pin's copper surface for more than a few seconds. Too much heat can cause paint and resin on the front side of the pin to melt.



Place the post over the solder flux and press it flat to the pin's back.

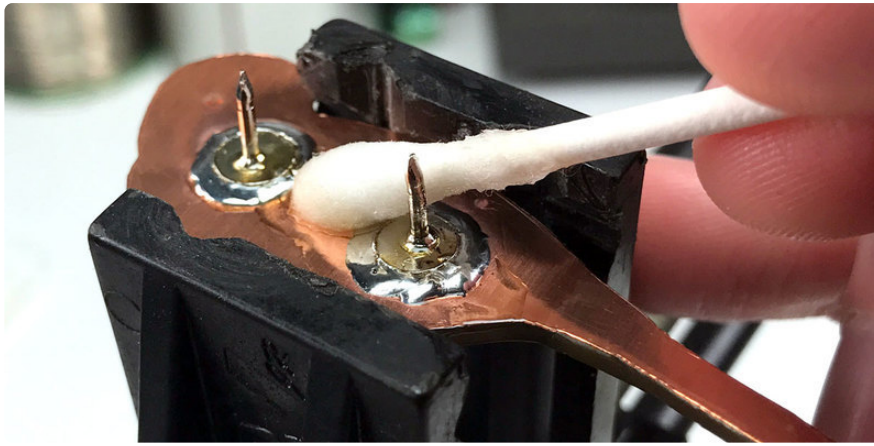
Since this is a wearable item, it's a good idea to use **lead-free** (ROHS compliant) solder.

Solder one point on the edge of the post's base to the copper - this will secure it in place while we solder the rest of the base.



Beginning on the opposite side of the post's base, **solder the edge down** by dragging the iron along the seam while simultaneously feeding solder wire into the iron's tip. Repeat this process to solder the remainder of the post's edge to the pin.

I soldered an additional post to prevent the pin from rotating when worn.



Once your posts are securely soldered, **allow the board to cool**, then remove it from the vise. **Remove any excess flux** with alcohol and a small cotton swab.

Finished



Congratulations - your pin is ready to wear. Take a moment to appreciate its originality, craftsmanship, and aesthetic appeal - then wear it with pride.