

Making Your Own Circuit Boards Using the Photo-Etching Process!

Written by Anthony L. Mach, AB9IO for the Fox Cities Amateur Radio Club

One thing that has forced many of us to limit our electronics experimentation is the lack of an easy and affordable way to make circuit boards. It really isn't that hard to do! I'll show you how...

1. Get the board: You'll need to get at least one photosensitive board. I like MG Chemicals 1/32" or 1/64" thick boards. These can be cut with a good pair of kitchen scissors. Get them as big as you can and cut them down. Mouser has 6"x9" boards (Mouser part no. 590-689) that are 1/32" thick for about \$16 each. If your projects are small, you can get a lot of boards out of there! In a darkened room, pull the board out of the protective packaging and (keeping the black plastic coating on) cut your chunk out.

Notice: These are *positive* photosensitized boards. That means that whatever is black (where light can't shine through) on the mask will be black on the board. Cover up what you want to keep! When you make your transparency mask, the board traces will be black!

Put the rest of the board back into the protective packaging. You will notice when all is said and done that the edges where you cut will lose their photosensitive coating – that's ok, just make sure you allow an extra 1/8" all the way around for the board.

2. Get the developer: Mouser sells a MG Chemicals developer. This is a must have! The Mouser part number is 590-418-500ML and it runs about \$10 per bottle. This stuff is about 4-10% caustic soda in a solution of water (NaOH). Don't get it on anything you want to keep – it eats skin, eyes, clothes, etc.

3. Get the etchant: I'm sick of using Ferric Chloride and Ammonium Persulfate to etch boards. These are expensive, messy, and slow! At the hardware store, pick up a jug of Muriatic Acid and two bottles of Hydrogen Peroxide. Muriatic Acid (28-30% Hydrochloric Acid) is used to clean driveways and Hydrogen Peroxide is what your mom used to put on your "ouchies." Here's my new etchant that works best: One part Muriatic Acid and two parts Hydrogen Peroxide! With the acid, be very careful with this stuff; it will eat skin, eyes, clothes, etc.

4. Get protective gear and supplies: When you're at the hardware store picking up #3, I highly recommend you get a good pair of chemical goggles and chemical resistant gloves. Don't cheap out! Good nitrile gloves will save your hands. Get some foam brushes in a multi-pack. The 1" to 2" ones will be needed for the developing and etching process. If you don't have plastic dishes, get these too. I like the polypropylene sandwich containers that Glad® makes. It wouldn't be a bad idea to get some cheap plastic measuring cups, either. Notice the theme here: use plastic – **DON'T USE METAL FOR ANY CONTAINERS OR UTENSILS!** Hey, you'll also need two small pieces of glass (real glass). The \$1 4"x6" picture frames at Wal-Mart or Dollar General work great for this! Also, make sure you have some rubber bands handy!

5. Get your design and print it on a transparency: Remember to print black on the transparency where you want your traces to be. Either design your own layout or get a layout from the 'net.

Print as dark as is possible on the transparency. If you can see light through the printing, the board will not come out right. Print twice or three times on top – if you have to. Inkjet transparencies work, too! Just make sure they're dry before proceeding!

6. Get a fluorescent light: Don't worry about what kind of fixture to use, just use the regular old fluorescent tube lights that you have in the garage or basement. Will CFLs work? Maybe, but you'll have to experiment. Will regular light bulbs work? No! They have to be regular fluorescent lights.

Now, for the good part...

1. Print out the appropriate "artwork" on your transparency mask. For your first run, I recommend you try a one-sided board only. Two-sided boards can be done, but they require two masks that are lined up perfectly. Cut your design out so that it is bigger than the board but smaller than the pieces of glass.

2. Now is a good time to mix your chemicals. If you have your church clothes on, now would be a good time to change into something more expendable! Put on your gloves and goggles and have your foam brushes and a supply of fresh water handy!

Mix one part of the developer with ten parts of tap water in a plastic tray. Place this in a well-ventilated area outside where it won't spill. **Only make up what you need: try 25ml of developer and 250ml of water. This should be plenty! Don't breathe the fumes! Do this outdoors!**

In a separate plastic tray, make up the etching solution by adding one part of Muriatic Acid to the tray and slowly adding two parts of Hydrogen Peroxide. **Try 50ml of Muriatic Acid and 100ml of Hydrogen Peroxide.** The solution should be clear and may become somewhat warm. **Don't breathe the fumes! Do this outdoors!**

3. Dim the lights and make sure you don't have any fluorescent light creeping onto the board. A small regular light bulb can be used if you need it. Carefully peel the protective coatings off the circuit board – start from one corner and peel. Go slow!!! Line up the design(s), printed side against the circuit board. Sandwich this between the two sheets of glass. Carefully, use the rubber bands to hold the assembly together. You want to make sure not to crack the glass! Lay the assembly on something flat and dark so light doesn't creep around and expose the bottom side before its time!

4. Place your "sandwich" approximately 8" from the fluorescent light fixture and start a timer. I found that eight (8!) minutes per side works well. Watch to make sure the light is even over the surface. Don't push twelve (12) minutes per side – the board will overexpose. After eight minutes, flip the board and cook for another eight minutes.

5. After exposing, turn the fluorescent light off. Remove the rubber bands, glass, and mask from the board. Drop the board immediately into the developer. Brush very lightly with a foam brush – a bluish liquid will start to float away from the board and you'll immediately see your design

come to life! Keep brushing both sides lightly until all blue is removed from the part that is to be etched. You'll know it when you see it! Immediately, run the board under some cool tap water from the faucet to stop the developing process. Pat lightly with paper towel. You are almost there!

6. Drop the developed board into the etching solution. The solution will become warmer! Brush lightly with a *different* foam brush – both sides of the board. Do this until all unwanted copper has been removed from the board. You'll see the copper turn dark and melt away. Soon, you'll see the bare PCB peek out. You'll know when you're done when the board looks perfectly etched on both sides. Immediately place the board under cold running water or into a water bath to stop the etching. Pat dry. Marvel at your skills! You're done!

7. The remaining protective coating on the traces can be left on – if you want. It will just melt away when you solder. If you want to remove the coating, rub the board lightly with a Scotch Brite pad or equivalent – or try a little alcohol or acetone.

8. Dump the depleted developing solution down the drain with plenty of running water. This will not hurt your pipes or plumbing. Keep the etching solution tightly sealed and away from pets and children – it can be rejuvenated by adding a bit more Hydrogen Peroxide! When the solution is finally depleted, it can be disposed of properly according to local rules and regulations regarding copper solution disposal.

9. Make sure you keep your gloves and goggles on during the whole process!

10. Questions or comments???

Thank you and good luck making your own circuit boards!

Tony, AB9IO