Etch own PCB

To create own PCB at home you need to follow some simple steps:

- Mask the schematic outline
- Dissolve rest of copper
- Remove mask leaving just the copper tracks

In more detail:

- Get some copper clad board (FR-14 = fire resistant)
- Use LASER printer to print out schematic (reversed?) on glossy paper (e.g. HP glossy photo paper or even a glossy magazine page) – needs to be laser toner and the plastic sheen on glossy paper to form the mask
- Use steel wool (or 400-600 grit sandpaper) to polish the copper front (so it’s shiny) – this gets rid of the oxidisation layer
- Wipe copper to ensure no grease or fingerprints (alcohol / soapy water?) – now recommend JUST soapy water (alcohol leaves a thin film when evaporates) and paper tissue to fully remove fingerprints
- Place laser printed schematic face down on clean copper surface (tape to ensure doesn’t move)
- Now need to bond the schematic toner and glossy paper plastic on top of copper (will create a mask for later step)
  - Use hot iron to push down hard on paper/toner/schematic – if it’s a steam iron with holes then move it around so heat constant on all of copper. Use hottest temp – no steam
- Use a special PCB laminator (lots of times)
- Once it has fused with the copper, place copper with attached paper into warm water and leave for 5-10 mins – this will dissolve the paper.
- Gently rub off the paper (don’t use nails) – this will leave the toner mask for drops the schematic on the copper
- Now use chemicals to dissolve the copper (1 part ferric chloride to 1 part water OR mixture of hydrochloric acid and 1/2 cl hydrogen peroxide – prefer FeCl as it has less acidic fumes OR ferric chloride and of Hydrogen peroxide OR The etching solution is 2 parts hydrogen peroxide (available at any drug store) and 1 part muriatic acid (available at nearly any hardware store) – agitate for approx 20 mins – this will dissolve all the copper EXCEPT that protected by the toner mask. The chemical will only dissolve metal not the plastic mask! – It may be quicker to use a sponge (with gloves!) and rub the etchant over the copper surface.
- Next use different chemicals (alcohol / nail polish remover / acetone) to dissolve the toner mask. Use a cloth/paper towel with acetone – like using a polish. This will only dissolve the toner and glossy plastic covering but not the copper being protected underneath. It is best to do this when you are ready to use it...the copper will start oxidising when it is exposed to air. You can also remove with a soft scrubbing cloth and water OR Steel wool
- The spray I coat the circuit boards with is Techspray’s Fine-L-Kote HT, a conformal coating that prevents oxidation. It can be soldered through if necessary. OR soak in a tub of liquid tin (for max of 3-5 mins)
- Wash and rinse final board and leave to dry. Viola!
- Remember all chemicals will be reusable – pour back into a ‘used-once’ container.
- When drilling it is better to use HSS drill bits rather than Carbide (carbide will break more easily, HSS will
Ferric chloride is a traditional home-use circuit board etchant. It’s easy enough to come by, and the Ferric by itself is no big environmental problem. However, once you’ve etched a board with it, you’re left with a solution with a bunch of copper chloride in it. This dissolved copper is an environmental problem, and you can’t just pour it down the drain (legally) – you’re supposed to take it to a hazardous waste facility. (For instance: How to Dispose of Ferric Chloride in this FAQ.)

Wouldn’t it be nice if there were an etchant that you could re-use indefinitely so that you don’t have to worry about disposing of the copper, and that could be made in lifetime supply for like $10.00 with ingredients bought at hardware and drugstores? (And it’s prettier too.)

I got seven words for you: Copper Chloride in Aqueous Hydrochloric Acid Solution! (Exclamation point!)

But how’re you going to get CCiAHAS? Conveniently enough, by starting out with a simple two-ingredient starter etchant, and doing a bunch of etching.
Step 1: Ingredients: the Starter Etchant

For the starter etchant itself, you only need two ingredients: hydrochloric acid and hydrogen peroxide.

(OK, actually three. But the third one’s copper. See the chemistry section for an explanation.)

Hydrochloric (muriatic acid, “pool acid”, etc.) is available at a hardware store. The acid I got is 31.45% (or 10M) and should run around $5 per gallon. Which is more than you’ll ever, ever need.
The peroxide is normal 3% for mouthwash or cleaning cuts, and can be bought at a drug store for $2-3 for a big bottle.

You’ll also need a non-metallic container that fits your PCB and two standardized measuring cups.

As long as you’re in the hardware store, pick up some acetone if you don’t already have some. It’s useful for removing the etch resist. (That’s for another instructable.)

Step 2: Put the Lime in the Coconut...
Measure out two quantities of hydrogen peroxide and pour it into your non-metalic container.

Measure out one quantity of hydrochloric acid and pour it in. ("Do like you outha, add acid to water" to minimize the chance of an out-of-control exothermic reaction.)

Be careful with the acid. This stuff (at 10 molar) is strong. Mine fumed a bit when I took the cap off. Don’t breathe it directly, and be sure you’ve opened the kitchen window.

The starter etchant you’ve just made, on the other hand, is
not so bad — around 3M HCl with a medium-strong oxidizer. I find it doesn’t fume much at room temperature when I’m re-using a batch.

That said, you’ve got to be very careful to keep it away from metal — especially your stainless-steel kitchen sink. It’ll eat the stainless coating right off. Keep plenty of water flowing at all times when you’ve got any of this (even a drop) near the sink.

**Step 3: Add PCB and You’re Etching.**
Toss the PCB into the solution and it’ll take off.

If this is the first time you’re using this batch of solution (and I presume it is), it’ll etch super-fast. This small board took only 2 minutes. Yikes!
Since I use a deep container, I tend to swirl it around as it etches. This stuff is so active, though, that I’m not sure it’s necessary.

Keep the window open for ventilation because the starter solution gives off a little chlorine gas. (The end-etchant gives off much, much less.)

Also, note how the etchant gets greener over time as it eats away the copper. This is good news.

What’s happening is that you’re dissolving the copper from the board and turning it into cupric chloride. In the long-run, the cupric chloride will be doing most of the etching (instead of requiring disposal). For now, just watch your solution turn light green. Next time you use it, the color will deepen.

Step 4: Chemistry Break

(Note: I’m an economist, not a chemist. Please leave a comment if you’ve got any corrections and/or additions to this stuff!)

I stumbled on this idea when I saw this website: Etching with
Air Regenerated Acid Cupric Chloride by Adam Sechelle. Cupric chloride can be re-used indefinitely by topping up the acid levels and adding oxygen (bubbled in from the atmosphere). Sounds cheap and environmentally friendly to boot.

The website’s got a lot of good chemistry info on cupric chloride etching. His data on etching speeds is great, and his simple titration procedure for maintaining the acidity of the solution is pretty nice.

To make the cupric chloride solution, he dissolves a bunch of copper wire in hydrochloric acid, and mentions maybe using hydrogen peroxide to speed up the oxidation, but doesn’t go into detail.

Which got me thinking. You didn’t have any cupric chloride yet, but you can make it by dissolving copper. Dissolving copper is the name of the etching game. So we can make one etchant that makes another etchant that’s infinitely rechargeable. Elegant.

Turns out that hydrochloric/peroxide is a common home-brew etchant (and I’ve re-re-invented the wheel, again) but I guess that people got so used to throwing away their “spent” etchant that they don’t think about re-using it. The whole point of this instructable is that you don’t throw it away, but use the dissolved copper forevermore as your long-run etchant.
Here’s what’s going on chemically:

Before there’s much copper dissolved in the solution, \( \text{Cu} + 2 \text{HCl} + \text{H}_2\text{O}_2 \rightarrow \text{CuCl}_2 + 2\text{H}_2\text{O} \) is the dominant net reaction. That is, the extra oxygen in solution from the peroxide is oxidizing the copper metal, in presence of the acid, to make copper (II) chloride. That’s our starter etchant. The resulting \( \text{CuCl}_2 \) should be a nice emerald green color.

After you’ve dissolved a lot of copper into the solution, and used up all the peroxide, the copper chloride does most of the etching for you: \( \text{CuCl}_2 + \text{Cu} \rightarrow 2 \text{CuCl} \). That’s the end etchant.

Eventually you etch so much that you convert all the \( \text{CuCl}_2 \) into \( \text{CuCl} \), which doesn’t dissolve copper (and is a yucky brown color). As long as you’ve got enough acid in the solution, you can simply add more oxygen to re-oxidize the copper(I), making more copper(II) chloride and water: \( 2 \text{CuCl} + 2 \text{HCl} + \text{O} \rightarrow 2 \text{CuCl}_2 + \text{H}_2\text{O} \). And then you can etch again.

Bottom Line:
Two things to maintain: CuCl₂ levels and acid levels.

CuCl₂: After all the peroxide is used up, and the solution starts turning brownish, you’ll have to add oxygen to regenerate the solution again: toss in a few more capfuls of peroxide or bubble air through the solution or swirl it around vigorously, or just pour it into an open container and wait. It’s easy to tell when you’re ready to etch again, because the solution turns green.

It’s also impossible to add too much oxygen by adding air, so bubble/swirl to your heart’s content. If you’re using peroxide to add oxygen, be sparing — a little goes a long way, and it’s mostly water so you’re diluting your etchant by adding it.

Acid: Note that HCl is being consumed in the starter etchant and the regeneration reactions. So we’re going to have to add a bit more acid as time goes by. If you notice that it’s harder to re-green your brown etchant, it’s probably time to start thinking acid.

I’ve tried the titration described on Adam’s site a couple times, and it’s pretty easy but requires an accurate scale and pure lye (back to the hardware store…). It’s easier to just toss in a capful of acid every few batches of boards, which seems to do the trick for me.

**Step 5: Save the Etchant for Next Round.** You’re
Once you’re done etching, pour the etchant back into your storage bottle, rinse off the board, flux, drill, populate, and solder.

Some final notes here:

1) You can make quite a bit of this stuff very easily, and since you’re re-using it, there’s no real reason to skimp; put plenty of etchant in your “tank.” When you use too little FeCl etchant, for instance, it can get saturated with copper and slow down which can result in long etching times and pitting or undercutting or worse. When I’m etching a board with copper chloride, I’ll pour a couple extra inches of solution into the
container. It’s reusable anyway, and the extra exposure to oxygen just regenerates it. Live large.

2) Don’t make too much. As you keep re-using the solution, you’re going to need to add a little more acid and a little more peroxide every once in a while. If you’ve got a 750 milliliter container, start out with less than 500 milliliters of solution. Give yourself some room to grow over time. After all, the main point is to avoid having to dispose the copper in spent etchant.

3) If you’ve got too much volume of etchant (it will happen eventually) you can evaporate out the extra water by putting it in a shallow (non-metallic) pan or beaker or whatever and letting it sit for a while. This concentrates the copper in solution, giving you a stronger etchant. It’ll also re-oxidize some of the copper for you, a bonus. Remember when you’re adding the peroxide that you’re actually adding 97% water.

4) The linked website suggests that the acid levels in the etchant are not critical as long as there’s some acid in solution to do the CuCl2 regeneration. The amount of CuCl2 (vs CuCl) present is easy to diagnose by the color of the solution. Add oxygen to re-green, and add a bit of acid if that’s not working. Worst case is that you may have to wait a few more minutes per etch with a sub-optimal bath. This isn’t rocket surgery.
5) I do have an aquarium pump ($6 at fish store) that I’ve used to re-activate my solution. Sometimes I’d leave it on for a few hours while I’m at work if I’ve been etching a lot. But lately I’ve been lazy/impatient and tossed in a couple capfuls of peroxide. Both seem to work just fine.

6) The environmental benefit of etching with copper over ferric lies mostly in not having to dispose of the copper that comes off your boards every few times you etch. When and if you do end up with too much copper etchant, please treat it like the hazardous waste that it is — look into your local hazardous chemical disposal options. There’s no getting around the fact that copper salts are (for instance) poisonous to fish even in very dilute concentrations.

**Step 6: Alternative (overly-complex) Method:**
Make Cupric Chloride Faster.
When I originally started trying to make Cupric Chloride etchant, I hadn’t thought of just using the regular procedure of etching to get there. So I deliberately dissolved a bunch of copper from a wire.
I don’t think it’s a particularly good idea, but here’s how I got to the end-stage etchant faster.

I mixed the acid/peroxide 1:1 instead of 1:2. The idea was to have a bunch of acid leftover for later regeneration. I don’t think it’s a good idea, and I wouldn’t do it again. 1:2 is probably better, and results in more copper in solution faster with less fuming.

To control the fumes, I used the patent-pending (just kidding) Two-Pint-Glass Fume-Containment-Apparatus. Pour in the peroxide, add the copper, then put one glass on top of the other. Pour the acid down through a small gap between the two glasses and re-seal. Voila. No fumes. (See video. I think I did it with water as an example.)

I also kick-started the formation of cupric chloride by first making copper oxide, which turns to cupric chloride just in the presence of acid alone. This isn’t necessary at all, but it was fun. Heat up a coil of copper wire on the stove to red-hot and you get a flakey coating of copper oxide.

Otherwise, it’s basically the previous procedure, so just see the pics for notes. I wouldn’t recommend it anyway. The less copper you dissolve, the less copper needs to be (eventually?) disposed of, and the acid/peroxide etchant is plenty easy to use.
The two-cup technique is cute. I still recommend it.

quick etchant 00073.avi

Comments

rkrishnan7

2016-12-16

I revisited your excellent ‘ible today and want to ask for your advice on the following:

1. Can I render the CUCl/CuCl2 leftover (after many etchings) safer to the environment by mixing in some NaHCO3 (Baking Soda) – It’s a little messy with all the CO2 bubbles, but would the Cu Carbonate left in the end be more benign to the environment?

2. Would it be possible to reduce the solution (by evaporation) to crystals that can be stored more compactly? A few summers ago I set it outside in a large black pan for several days in the sun, but there was just a little encrustation in the periphery. So I tried heating it in a pyrex vessel, but fairly pungent chlorine vapors forced me to terminate that technique.

dtarusrkrishnan7

2017-06-12

the toxicity comes from the Cu cations, the anion is
irrelevant; if you really want to render it inert you have to revert it back to metallic Cu using some sort of electrolysis – you could use it to plate some object with the resulting copper

**JeremiahJ25**

2017-06-08

Works just like described, very fast and almost no fumes. I’d been using the vinegar/peroxide/salt with very mixed and mostly poor results. Also using a cold transfer method to transfer to the pcb. Thanks!!!

**millingby**

2017-03-28

Thanks for the great lesson. I tried this method, exactly as you described 1:2 ratio, and it took over an hour to dissolve my 70mmx100mm clad. On the second board I made the same size, I added an air stone to my container and the one end that had the bubbles under it, etched way faster than the other end.

It was a fresh mix like you did, when you said two minutes, but I got nothing like this. My container is a plastic Tupperware sandwich dish, so the airstone is just sitting in an inch of solution at one end.

Where do you think that I went so wrong as to get such a slow reaction?

My H2O2 was not brad new, maybe kinda old. Could that do it? The Muriatic acid was the same % as yours, although mine didn’t mention the 10M part. (A Canadian thing perhaps?)

I would love to hear your thoughts on this, I love the DIY
aspect of it. plus it’s way cheaper than ferric chloride were I live. $10 for your method, vs about $90 for the ferric chloride option.

Any pointers would be great. Thanks in advance from Vernon BC Canada!!!

FokkoPmillingby

2017-06-01

It might very well be that your peroxide is old. That stuff tends to degrade due to pretty much everything.

Peterthinking

2017-05-30

I wonder if you could use the solution for copper plating between etches?

DriesC2

2017-04-27

Hi from sunny South Africa. Thanks for a great post. I tried this today with great results in 3 minutes. I sacrificed a pcb blank to test the different permanent markers and the best one was a “Artline 70” xylene free marker. The tip is thin and I managed lines less than a millimeter.

Morgan63
2017-03-26

This is EXACTLY the info I was looking for! I’ve been using Ferric Chloride for years and I’m VERY excited to try this ‘better etching solution’. I see another jeweller successfully used Staz-on ink as a resist. Will Sharpie marker also act as a resist? Black or red or either?

JamesW440

2017-01-27

IMHO: Although I think this is an excellent instructable, I think it has too many dangers. I am going to try the vinegar with hydrogen peroxide method proposed by another instructable and use the ‘in hand’ gentle washing with a sponge as described in another instructable. There also is a lot of good information in Robot Room about a program called Copper Connection – I have tried it and it is very good. A PCB maker has also provided a program called PCB Artist. Both of these are free, but I like the Copper Connection much better. The only reason that I tried PCB Artist was that it offered auto-placement of the parts. Unfortunately, it did a very poor job. I was able to use some of the program’s techniques, however, and layed out the board much better. I have also purchased a Dell C1760nw color laser (LED) printer and the output at high resolution is outstanding (1200 dpi). It was only $100, not much more than an inkjet.

If you are wondering about what I consider dangers – just read some of the reports of people who tried muriatic acid. When a reaction begins to heat things up, it can get away from you. I have enough ‘bad luck’, I do not need to look for an accident trying to find a place to happen. I am not sure why these over heated and over etched, but Muriatic acid is nothing to play with. Vinegar on the other hand reacts much more slowly – is
extremely inexpensive and I would not be afraid to use my bare hands to handle the PCB except that I don’t want to put contaminants on the PCB. And the resulting compounds can be tossed down the sink. Or if you wish, recovered.

jameswcoxiiiJamesW440
2017-02-25
I used this method and it works fast… which is what I like. If you like slow and safe then im sure you can find all the supplies you need at the local elementary school.

The Real ElliotJamesW440
2017-02-05
Do what you want, and what you feel comfortable with. But…

The reaction of acid with copper is not exothermic, and will not “get away from you”. That’s HCl and aluminum. (Which is a whole different ballpark of danger/fun.)

“Muriatic acid is nothing to play with” is correct, but we’re not “playing” here, we’re using it. And before it gets diluted down to the final etchant, 10M muriatic _is_ a strong acid and you don’t want to spill it all over, for instance. But it’s un-dangerous enough that you can pick it up in the hardware store without any hassle. People tune their pool pH with the
stuff all the time without a chemistry degree. Add acid to water.

Vinegar as an acid: OK if you’re afraid of the strong acid, or have storage issues. It’s not cheaper or purer, just more diluted. But _do not_ put used etchant down the drain when you’re done with it. It’s the copper salts that are the problem, and they’re present whether you use this etchant, ferric chloride, vinegar, or dragon’s tears.

No matter what, I wouldn’t be doing any of this with my bare hands. The limited copper exposure is _probably_ benign. But I’m not really down with “probably” when it’s avoidable. Use gloves or tongs.

JamesW440The Real Elliot
2017-02-06

OK, the term ‘play with’ is not comparable to ‘using’ – not funny, you knew exactly what was meant – it is not uncommon usage. But, yes, you are ‘playing around’. Even your comment following that about levels of ‘danger/fun’ suggest that you are.

And I have ‘used’ muriatic acid in several different ways, including in a pool (I better say ‘and others’). The fact that you can buy it at a hardware store does not negate the power of it. HCl is much more potent even at a lower percentage depending on what it comes in contact with. If you get HCl on your hands, you will know it – that was the point. Vinegar,
not so much. And I think it can be easily surmised that I was talking about it in the same vein as you were. The concentration available in stores for both – those would be the comparison. The change of meaning of your comparison just muddied the water.

And no, the acids ARE different. One is HCl, the other is citric acid. Citric acid is not nearly as reactive as HCl. You can’t usually obtain citric acid at higher concentrations in a grocery store, although you could make it higher. Citric acid in vinegar is cheaper by a long way. I can find vinegar in 12 oz container, while the muriatic acid is nearly a full gallon – it is not hard to figure out what was being indicated. Perhaps if I put them out for sealed bids on several thousand gallons of each, we could make a better comparison, but for what reason?

You can even make vinegar at home, if you want, from produce that you have around the house... HCl not so easily done. The purity was not in question. Even if you reduced the concentration of the HCl, it would still react faster and stronger in the etching process. Again just an informed opinion.

My point about the ‘bare hands’ is that it won’t burn you and as far as the copper salts, how many things made of copper have you handled in the last week. Are you sure that they didn’t transfer ‘copper salts’ to you? If you are that concerned about copper salts, you shouldn’t even be doing this.

Do the copper salts stay forever? Weren’t they all over the environment in some quantity before we started? If this is a concern, does your instructable say how to dispose of them. What, not important enough to specify exactly? So what do you think is going to happen with all of this copper sludge? Just a rhetorical question.
As I stated up-front – IMHO, the instructable is excellent. It is very usable. But I am going to see how it goes with a different acid – citric because the suggestion is that some had overheating problems and I am familiar enough with acids that I don’t want to take that chance if I don’t have to. I am not ‘concerned’ about HCl – I just would rather not deal with it, and it is very reactive.

I will revert to this method if the other one doesn’t work, but I think I prefer to use a scrubbing method rather than let it sit in the pan till it’s done. Just an opinion. I know – you said I could do what I want, but the rest of your retort sounded more like remonstrance on being so ridiculous – hmmm isn’t that ridicule?. Sorry, that is the way I am thinking right now. I am planning to try the method today.

JamesM808

2017-02-23

I know “vinegar” seems inherently safer for home experimentation than “hydrochloric acid,” but as others have pointed out, you have to be careful swapping out organic acids for mineral acids.. the resulting metal complexes can be bioactive and more threatening to health than a simple superficial burn or contact dermatitis. Once it absorbs into your bloodstream, it has the potential to affect any/all of your organs. Hydrochloric acid has all the same ingredients as seawater, just slightly different concentrations.

JamesW440

2017-02-24
The vinegar was suggested in another instructable. I don’t like HCl so I looked for something else. Everything else about this instructable is good for the vinegar/hydrogen peroxide method as well.

BradG66JamesW440
2017-02-22

Vinegar is not citric acid. Citric acid is the acid in lemons and such that make them sour. Vinegar is a mixture of acetic acid (usually 5-20%), water, and sometimes other trace chemicals. Higher concentrations of acetic acid are just as dangerous as highly concentrated HCl. Vinegar isn’t a highly concentrated mixture by any means, and it is quite safe and effective in it’s grocery store concentrations. Proper PPE and handling precautions should be used with any type of chemicals like this, but use what you feel safe using.

@scallipus: Please don’t pour the peroxide into the acid. The peroxide is mostly water and you always, always, always want to add the acid to the water. By adding the acid to the water/peroxide, the ratio of acid to water starts at 0 and goes up. This way the heat generated is easily controlled by adding it slowly. If you add water to acid, the acid is at it’s highest concentration from the start and is then diluted as you add more. Doing it this way allows the full amount of acid to potentially react and generate a ton of heat and can quickly get out of control.

Also, just as JamesW440 said, high concentrations of peroxide can be very dangerous. I’m not sure how bad 12% is, but I know that higher concentrations can kill (oxidize) skin cells
instantly and continue doing so as it penetrates deeper into the layers of skin. There’s really no reason to use stronger peroxide than what you can buy at the drug store, there’s really no advantage.

JamesW440BradG66

2017-02-22

Red flags went up in my head when I wrote that, but I failed to check what they were about – of course, you are correct. I doubt that citric acid would even work at 5%, but you are not planning to get someone to believe that all acids are created equal, are you? If so, I point you to hydrofluoric acid and sulfuric acid which are more active at the same concentrations, as is HCl, while acetic acid and citric acid are not nearly as active. It depends on the material it is being used on. The acetic acid that I bought at the store was 5%. It worked beautifully on the Cu clad board – only my process was somewhat flawed and it etched most of the traces off because I used an inferior version of permanent marker.

Please credit ‘soulofscience’ (in later posts) with the conviction that 12% is too dangerous. I have no experience (and don’t want one) to make any claims about the safety of it. I was successful in mixing my 12% down to 3% – I had the 12% for medicinal purposes, but refused to use it once I tried it. So I had it on hand, so to speak. I only pointed out that you could buy it and how to mix it to get 3% for use in the solution. And when I ran out of the mixed 3%, I had used 12% directly for one batch that I made with no adverse effects. After that I mixed it all down to 3% so I won’t be using it again.
what I found through experience with regards to the exothermic reaction, is not when you are using the final solution to etch with, it is when you are adding the oxidant initially... if you add 3% peroxide to 38% acid, there is little thermal heat generated, When I did my first batch using 3% peroxide bottles, I simply had the acid sitting in a pyrex glass dish which was sitting in water at room temperature (straight out of the tap), there was zero fuming...

When I made the second batch using a bottle of 12% peroxide, I did the same thing except I added some ice to the water mixture to help keep things cool, I added the peroxide steadily and slowly, there was some minor fuming forming on the surface of the acid but other than that, it was fine, after the mixing in was complete I let it sit in the water for about 15 minutes until the fuming stopped, signalling the end of the reaction...

This worked just perfectly for me... I personally am well aware of the dangers of acids and had suitable PPE for handling them along with a hose on standby if something went wrong...

When handling ANY acid, IMHO no matter the concentration, mono goggles are a must, as are nitrile or rubber gloves and long sleeved cotton shirt to go over the open end of the gloves and I did have on denim jeans and an apron in case there was some
splashing on the legs...

Where people get into trouble with acids is adding things the wrong way or trying to rush and adding things without care... taking some simple precautions and reading up on how from as many different sources as possible on how to approach something you have not tried before is also a very good thing to do...

Going into making this solution, I can state categorically I had essentially zero training in handling acids in dangerous concentrations, or in which order to add things etc... Thankfully these days there is a plethora of information available which IF people take the time to look at and also employ some common sense and in doing so plan for the worst but hope for the best, makes the process a lot less risky

JamesW440scallipur

2017-02-20

I think you should read soulofscience’s response to my use of 12% a few entries above here – you could be ‘playing with peroxide’ and get your butt burned. Stick with the 3% is my suggestion. I have converted all of my 12% into 3% so I can make some more PCBs. Although I didn’t see anything that gave me concern, I don’t need to risk my neck over something so cheap as hydrogen peroxide. I had 3 16-oz containers of ‘food grade’ hydrogen peroxide that was to be used for medicinal purposes (internally) I balked. So now I have made all of it
into 3% which is the only stuff you should be using according to soulofscience.

JamesW440scallipus

2017-02-20

Interesting – as I have said repeatedly, I would NOT use 12% peroxide. I mixed mine down to 3%. Then I poured the two together with no reaction that was perceivable. (Acid into peroxide.) When I used 3% with 5% Citric acid in a 40/60 ratio, it worked like a charm. I had most of my problems with the transfer onto the board. The printed paper would not transfer to the copper well. So I tried to use permanent marker, but it etched right off.

My first try was a bummer – the acid was too old – it did absolutely nothing. So I bought some new stuff at WalMart and away it went. It took a quart of mixture to do a 4.5 x 6" board. But like I said it ate off the permanent marker and the copper under it. Where the toner was still on the copper, it worked well.

I tried plain paper, I tried magazine paper, and now I have purchased some transfer paper and will try again when it arrives. So thus far, I have a big goose-egg.

JamesM808JamesW440

2017-02-23

I just tried this, and it does indeed work spectacularly! It is much more rapid than FeCl3, as claimed. It also costs only a few bucks to accomplish what would require probably about
$200 worth of FeCl₃ etchant. I have some thoughts, as a person who’s been playing with explosives and chemicals since middle school and still has all his fingers and eyes:

Most importantly: a high school chemistry teacher would give you a zero for mixing unidentified chemicals by volume. You’re supposed to titrate/assay, or at least broach the topic by doing a rough check of the label.

H₂O₂: Hydrogen peroxide can be dangerous in high concentration but IMO the discussion here about concentration is irrelevant. You need such a tiny amount of H₂O₂ (you need none at all, in truth) to get this reaction started that unless you’re mixing up 10+ gallons of etchant, you do not need to shop around for a volume source. A splash will get the reaction started.

HCl: Most people here have overlooked the fact that “ferric chloride etchant” you used to buy at Radio Shack and can still order from CRC/Jameco/etc is a mixture of ferric chloride and acid, not just ferric chloride… It’s also very environmentally toxic just like this stuff is.. so you shouldn’t be comparing the two processes as if one of them is safer. I used Behr “user-friendly muriatic acid,” and was immediately worried about whatever “friendliness agents” had been added.. but the resulting mixture was almost completely clear and did not seem to etch any differently than I expected. The concentration is allegedly low enough that it “won’t damage uninjured skin,” whatever that means. But it’s also low enough that you can simply pour together a quart of solution and it will get only slightly warm.. but see my complaint #1.. all I can say is, whatever the concentration is (since Behr didn’t find it prudent to mark it), it’s low enough that I got away with it. Your results may be more or less exothermic.

As for inks, you have to find the right resist. Each process has inks that do and don’t work. I’ve been making circuit boards for decades, and red Staedtler Mars markers (the non-erasable variety) have proven to be the best resist pens I’ve
encountered. I’ve also used oil-based screen-printing ink (which wipes off instantly with paint thinner), model paint, wax, that “blue stuff,” and dry transfer patterns, all of which outperform a simple black Sharpie by a slight margin. But I’m sure there’s a perfect resist for this process somewhere on a shelf in Staples.

The process does give off a lot of foul-smelling gas, only some of which I’d wager is chlorine. I’ve met chlorine and recall her being quite a bit nastier. But you definitely want to do this in a well-ventilated space or outdoors. Wear gloves, goggles, and grubby clothes, and keep appropriate safety equipment nearby, and you will be fine.

JamesW440 JamesM808

2017-02-24

Hi I am not certain why you responded to my post, but OK. I did not mix unidentified chemicals by volume. I knew what they were supposed to be and the first try showed that the vinegar was no longer active – it had somehow neutralized. Other than that I merely relied (cautiously) on the labeled product.

As far as the inks, I was told that permanent Sharpie marker would work, I used a form of it that did not work – too late once you’ve done it, but thanks for the heads-up on Staedtler Mars non-erasable.

scallipus

2016-09-23
Thank you very much Elliot for this Instructable. I was able to get my solution (2 parts hydrogen peroxide 3% and 1 part Hydrochloric Acid 38%) and mixed in a very short time and began etching. My PCB turned out a dream in only a few minutes.

I used a pyrex glass 1 litre jug as the mixing bowl with that sitting in a bowl of water to help cool the solution if things got too hot. No fuming at all, stripped the 4” x 3” pcb leaving just the circuit behind in just a few minutes.

A couple of questions though as I am not that strong on my chemistry.

1st.
The peroxide I used is from the supermarket medicine section and the solution turned brown when I added the acid. I am guessing there might be some kind of dye in the peroxide solution?
2nd question, in
the preparation for this I found some 12% hydrogen peroxide at the
‘beauty section’ and as it was a lot cheaper per volume than the 3% from
the medical section I brought a bottle of that. It is a ‘creme
developer’ and contains other chemicals. specifically CETEARYL
ALCOHOL,
SODIUM LAUREL SULPHATE, PHOSPHORIC ACID, ETHANOL,
METHYLPARABEN

I
am worried about mixing this (diluted with water down to 3%
pерoxide)
with acid. Has anyone else tried this sort of solution before? I could
not find any straight hydrogen peroxide at 12% that was liquid like the
3% stuff from the medical section.

Price difference is 4 bucks for 200ml at 3% vs 10 bucks for 1
litre 12%
There is a pure 12% hydrogen peroxide available, but it is expensive by comparison. You can google it. I would not recommend using that peroxide you found with that other stuff in it! To make the adjustment from 12%, you do ratios 0.12 per unit vs 0.03 or 12/3 = 4 so you need 1/4 as much 12% to get the equivalent of 3%. Then adjust the volume for the amount you want to mix.

As far as the acid/peroxide turning brown, it sounds like you got some sort of reaction — were you using Muriatic acid, or something else (a combination cleaner of some kind)?

Using higher percentages of peroxide has dangers associated with it. At higher percentages it becomes an aggressive oxidizer which can cause it to catch fire when it comes into contact with some materials.

Only use it if you know what you are doing.
If you read what I said, I did not suggest using higher concentrations of hydrogen peroxide — I just told them how to make the 12% into 3%. This is perfectly legitimate and not any more unsafe than using hydrogen peroxide at all. In fact, the 12% I am talking about is food grade and is ingested by people directly after they build up to it.

12% is still high enough that it can have negative reactions with a lot of compounds. Not as bad as 30%+ where dropping a potato into it causes it to explode, but still strong enough that you need to be aware of it.

Especially if you are mixing it with acid as these solutions are known to be much more aggressive than the acids by themselves.

Peroxide in anything greater than 6% does pose a hazard and you need to be aware of it if you are going to use it.

So what? Can you not read? Are you still not aware that you are talking to me about something that I never suggested? You will not find any suggestion to use 12% or anything higher than 3% in the etching solution. All my comment says is how to change 12% into 3% so presumably the person who uses 12% would
actually use 3% in the mix, otherwise why convert it. That does NOT mean to put 6% or 12% into the acid, does it? Try to comprehend before you make statements like that.

All your talk about danger this and reaction that is probably true, but it is not what is being suggested by anyone – at least not by the one to whom you are aiming your comments.

As to your 6% comment at the end – people use the 12% to drink. That means they ingest it. First they mix it with water, but they build up to being able to drink it at higher concentrations. I don’t remember now exactly what the concentrations are, but it is pretty high. I’ll see if I can find it if you keep this up. Your warning about 30% is probably wrong too. I doubt that you can make hydrogen peroxide stable at 30%, but that is just a guess.

I will tell you this, I have put 12% directly in my bathroom sink and all it does is bubbles a little on scum on the edge of the fixtures. That is all.

soulofscienceJamesW440

2017-02-18

“You will not find any suggestion to use 12% or anything higher than 3% in the etching solution.”

No I can read, the problem is you don’t get what I am saying. I am saying is even if you plan on diluting it, 12% peroxide is still dangerous to have around and you need to know how to handle and store it. It won’t burn human skin, but it is a highly reactive oxidizer and it can also act as a catalyst for a lot of reactions.

Peroxide can react negatively with a host of compounds. In fact hydrogen peroxide can be an EXPLOSIVE! But even things as
simple as Vinegar can react with peroxide to form some pretty nasty stuff. Now usually at 3% concentrations it is too dilute to be dangerous, but if you have 12% or higher you actually have a high enough concentration to actually cause a significant reaction.

Even things as innocent as baker’s yeast has a reaction with hydrogen peroxide. It generates pure oxygen. This stuff is no joke which is why pharmacies and stores sell very dilute solutions of it.

“I doubt that you can make hydrogen peroxide stable at 30%, but that is just a guess.”

Dude, 30% is lab grade I’ve used it before. I’m a chemist, I’m tell you this because I’ve worked with this stuff before.

https://www.flinnsci.com/hydrogen-peroxide-30-reag...

At 30% the enzymes in a potato are enough to cause an explosion.

JamesW440soulofscience

2017-02-20

Sorry I am not a chemist, but I am an engineer. I have used 12% and someone else here (maybe you) had used it too. So, I can’t argue with you that it is not dangerous and didn’t. But 12% is not nearly as reactive as you suggest. You couldn’t get me near 30% so...

Now after actually trying it with the Citric acid, I made one batch going from 3% in a ratio of 40 to 60. The next batch I used 12% with the proper proportion to get to 40 to 60 and it worked exactly the same as the first batch. No, I didn’t go in there and measure temperatures, etc. But the exothermic
reaction was benign at worst. (I had to wait almost a minute to begin to see bubbles appearing on the surface of the board in the tray.) This goes along in agreement with another post in here.

I wanted to use my gloved hands to gently agitate the solution, but it was taking too long and I could not keep the permanent marker on the board, so I used a tray. It took almost an hour to do the 4.5” x 6” two-sided board in the tray. I had to add solution every 15 minutes or so. I poured off the used solution and poured on new (I was only putting 16 oz of solution on and it took three times that, but the last one wasn’t used up. The reaction was bubbles, not heat (this is citric acid, not muriatic)

The next one I try, I am going to put the board into a pan big enough to hold a quart or more of solution and rig it so that I can agitate it. (I really should be putting this on the other hand-held etching instrucutable, but I put it here in response to your comments.)

Any thoughts on that?

soulofscienceJamesW440

2017-02-20

“I have used 12% and someone else here (maybe you) had used it too. So,

I can’t argue with you that it is not dangerous and didn’t. But 12% is not nearly as reactive as you suggest. You couldn’t get me near 30% so…”

The biggest issue with even 12% peroxide is there is a host of compounds you can mix it with that will generate some really nasty products. Don’t let the 12% number fool you, you are
working with ~4 Molar H2O2 which is more than enough to drive chemical reactions. 12% peroxide is official classified in many countries as hazardous waste. The reason 3% peroxide can act as a disinfectant is because it rips oxygen from organic material to decompose into O2 and H2O.

Hydrogen peroxide is a strong oxidizer and it can cause combustion reactions in absence of oxygen if mixed with the right compounds. In fact with 50% or higher you can actually ignite leather with it. But even in the absence of fire danger, there is still a large chemical danger where spilling it onto something can completely change the chemical make up of it.

This stuff is reactive. Just because it doesn’t burn your skin off immediately doesn’t mean there aren’t other dangers with it. (Although it’s well known that 12% can dissolve human skin if left in contact for long periods of time and it’s also known it can damage DNA) Peroxides are some of the most reactive compounds you will find outside of a chemistry lab.

scallipussoulofscience

2017-02-18

I did find some 12% pure hydrogen peroxide liquid in the local chemist, was 10 bucks for a 500ml bottle... and I calculated out the requirements for the amount of hydrochloric acid and made a batch up, using the double bucket method, a bucket of ice water with the acid inside a glass pyrex dish immersed in the bucket and the peroxide added to the acid, it kept it fairly controlled with only some very minor fuming from the 38% acid...
as it turns out, the diggers brand of Hydrochloric acid must contain some iron contamination as that is why it turns a reddish brown when adding the peroxide... It has come up a few times with other people here in Australia noting the same exact thing occurring with that brand... Apparently pool suppliers sell Hydrochloric Acid in the same approximate concentration (38% or 10 mol) as the brick cleaning one I brought from the hardware store but it probably won’t have the iron contamination in it I am told....

Still, it worked just fine for etching anyway so perhaps I just won’t bother as I have made up about 2 litres of etchant and set up a bubbler tank etc

The only problem with this is that the polymers in the ink can be sensitive to acid. You can potentially end up with a soup of random organics many of which can be carcinogenic. Many chlorinated carbon compounds are know to cause cancer. Especially if you reuse the etchant.

The nice thing about the ferric chloride (and why it is commonly used) is that it generally ignores the ink. Every chemist around knows you can use different acids to etch copper, but the reason they went with ferric chloride is because acid doesn’t just etch the copper.
bricofoy made it!

2016-12-13

Just made my first board using this mixture. Pretty fast although it is only 5°C here. (I did not measure but I thing more or less 10 minutes to get this 100*160mm board done.)

But the mixture removed the toner after a while, but the eching was not at all finished. I left it finish but I have lots of holes in the copper ans some places where the copper as become very very thin (where the toner was gone). I can’t understand why it removed the toner on copper but not the silk on front side... I transfer both sides in one time using a folded transfer sheet and putting the whole sandwich in my office’s laminator.

n6ng

2016-11-29

The pool acid I obtained was 14,50%, about half of what the article mentions. I decided to try the 2 to 1 ratio mentioned. So I should have about half the acid. My expectation was that the first etches would be a little slower than the two minutes mentioned. First etch took about four minutes, so it was easy to manage. I guess that you could do a 1 to 1 and have the quicker etch but I liked this result.

Can anyone with experience or knowledge comment on the long term viability of this solution?

This first circuit board was made with Sharpie ink as the resist. Depending on your skill, this can be a workable (but perhaps sloppy) technique.. If you try it, paint the traces
twice (nice and black). I got a little etch thru on a couple of my traces.

**smeem**

2016-11-07

Works really well except when it gets cold it seems to become 100% worthless like rewarming it did nothing, have to swish it around a lot until I get a air pump. Would a coffee warming plate be a bad idea to try and rewarm it with?

**JamesW440**

2016-11-03

This is a neat method. I would suggest looking into the ‘sponge bath’ method that another person used for Ferric Chloride etching. That method should work with these chemicals and allow one to make only enough to etch the current project plus not overheat everything because you have control over how much etching is going on at any given time.

I would not want to risk putting that much time and money into making a pc board and then have it etch so fast that it overheats everything. You might be a little apprehensive about putting your hands actually into this stuff, but use a slower reacting mix and it should do fine.

**HeadlessHamster**

2016-10-11
I can’t really get 30% hydrochloric acid, but can you use 10%, and then just make a 1:1 mixture, or something like that? My hydrogen peroxide is 3%.

2016-11-29

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