Vol. 6 Oxford V.U.E., Inc. Issue 1

News & VUEs

By Phil Culpovich

ETCHING MACHINE SURVEY

In any conversation pertaining to etchers and the control system used for regenerating the etchant, discussion will always include the topics of speed, quality, cost and reliability. When discussing the differences between the Vis-U-Etch™ 5 and all other systems using ORP and Normality for control, most people accept that their quality and environmental safety will definitely go up with our zero-free* acid cupric chloride but some are convinced that their speed will suffer prohibitively. This is because too many people have been convinced that high acid Normality is the last word when it comes to the speed of the etcher.

In a previous newsletter, we presented an article that highlighted the variables that affect etch rate and etch quality (Vol. 5, Issue 1). The article indicated that there are many items other than free acid that affect the speed. While the article's information is definitely helpful in determining what items to look at, it doesn't show any practical results with different pieces of etching equipment.

This has all changed now. One of our leading distributors in the mid-western USA, **Circuit Research Corp.**, has graciously engaged in the task of gathering data and organizing it into a chart (included with this newsletter) showing the effects of acid Normality, nozzle density and spray pressure on etch speed.

It is important to note that the chart does not test all models of equipment from each etcher manufacturer nor does it indicate the age of the etcher used. It is not intended to promote any etcher brand over another. All etching machines included in the survey are available in many different configurations, each with different specifications and performance characteristics. The purpose of the chart is strictly for the reader to see how the different features of each etcher affect etch speed.

An explanation of the columns in the chart is as follows:

Column 1: Lists etcher manufacturer
Column 2: Indicates total etch chamber length in feet.
Column 3: Indicates the average etch speed for etching one ounce copper panels to completion.
Column 4: Indicates the average speed to etch one ounce copper panels to completion per four foot section of the etcher tested. This enables a better comparison between etchers by comparing speed in four foot sections of each since all are of different total etch chamber lengths. A higher number indicates more efficient etch speed (faster).
Column 5: Indicates type of oxidizer used (sodium chlorate / hydrogen peroxide / chlorine gas) and the control system used (Vis-U-Etch™ 5 or Oxidation Reduction Potential / Normality).
Column 6: Indicates tested free acid content of etchant listed as Normality.

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* Typical acid Normality is => 0.04N

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Survey performed courtesy of **Circuit Research Corporation**, Delano, MN
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Cupric Etching Survey

Equipment Manufacturer	Etch Chamber Length (in feet)	Speed 1 OZ (IPM)	Average Speed (per 4 ft section - 1 OZ)	Etch Type/Control	Normality	Nozzle Type	Nozzles (per 4 ft section)	Spray Pressures	Oscillation Type
Schmid	17	130	**30.6**	Sod Chlorate/ORP	2.0-2.2N	Fan	130	45 Top, 40 Bottom	Manifold
ACS	18	120	**26.7**	Sod Chlorate/ORP	1.5N	Cone	55	47 Top, 27 Bottom	Sweep
IS	6.5	43	**26.5**	**Sodium Chlorate Vis-U-Etch™ 5**	<0.04N	Fan	134	44 Top, 39 Bottom	None
Chemcut	12	74	**24.7**	**Sodium Chlorate Vis-U-Etch™ 5**	0.06N	Cone	70	36 Top, 32 Bottom	Sweep
Chemcut	20	120	**24.0**	Sod Chlorate/ORP	2.0N	Cone	98	32 Top, 32 Bottom	Sweep
Chemcut	8	48	**24.0**	Peroxide/ORP	3.05-3.45	N/A	N/A	30 Top & Bottom	Sweep
Chemcut	16	90	**22.5**	Sod Chlorate/ORP	1.5 N	Cone	70	35 Top, 35 Bottom	Sweep
Chemcut	16	90	**22.5**	Sod Chlorate/ORP	2.0N	Cone	70	40 Top, 38 Bottom	Sweep
IS	9	48	**21.3**	Sod Chlorate/ORP	1.4N	Cone	55	42 Top, 24 Bottom	None
Chemcut	12	63	**21.0**	Chlorine/ORP	1.2-1.4N	Cone	56	30 Top & Bottom	Sweep
Hollmuller	9.2	48	**20.9**	Sod Chlorate /ORP	1.8N	Fan	163	30 Top, 28 Bottom	Manifold
ACS	12	62	**20.7**	Chlorine/ORP	2.0N	Cone	55	30 Top, 60 Bottom	Sweep 40/Min
Snic	24	122	**20.3**	**Sodium Chlorate Vis-U-Etch™ 5**	0.06N	Fan/Cone	56	15-20 Top & Bottom	Top Manifold Bottom None
Chemcut 547	12	60	**20.0**	Chlorine/ORP	2.0-2.1N	Cone	70	35 Top, 22 Bottom	N/A
Hyoki	12	60	**20.0**	Peroxide/ORP	3.05-3.45	N/A	N/A	30 Top & Bottom	Rotary
Chemcut	16	72	**18.0**	Sod Chlorate/ ORP	2.0-2.5N	Cone	56	28-30 Top & Bottom	Sweep
Chemcut	8	31	**15.5**	Sod Chlorate/ORP	1.5-2.0N	Cone	56	35 Top & Bottom	Sweep

Notes: N/A - Data is “Not available” OZ – Ounce
FT – Foot IPM – Inches per minute

Column 7: Indicates nozzle type used in the etcher (flat fan or cone).

Column 8: Indicates the quantity of nozzles per four foot section of the etcher, top and bottom.

Column 9: Indicates the spray pressures shown on the gages of each etcher for top and bottom spray manifolds.

Column 10: Indicates the oscillation type used in each etcher: Manifold (horizontal reciprocation), Sweep (swings in an arc over/under the panels), None and Rotary (nozzles spin in a circle over/under the panels maintaining 90^{o} spray contact with panels).

The first item that draws attention is the speed per four foot section because this is the best indicator of the etch speed efficiency of the etcher in general. This is not an indicator of etch quality. After looking at the fastest etchers compared with the slowest etchers, the "high acid is everything" crowd looks across to see that the acid Normality is actually all over the place and that some of the highest Normality readings are actually at the bottom with the slowest etchers. The real pattern to follow is the nozzle density and spray pressure.

As you can see from the data, the etchers that have the highest pressures generally have the faster etch speeds and the etchers with more nozzles are also in the fastest group. It is also important to note that having more nozzles with less pressure means a slower etch rate (Hollmuller etcher) and less nozzles with higher topside pressures can still deliver a faster etch rate (ACS etcher).

And what about acid Normality?...

If free acid really was the best indicator of speed, all three Vis-U-Etch™ 5s tested would be at the bottom of the list. Fortunately, this is not true and, in fact, a Vis-U-Etch™ 5 came in fourth fastest even with 46% less nozzles, 20% less top pressure and 20% less bottom pressure than the fastest etcher in the survey running at only 0.06N.

Looking at the slower Vis-U-Etch™ 5 reveals the true cause of the slower performance: Too few nozzles and very inadequate spray pressure.

IPC EXPO 2001

Time sure is moving quickly in the PCB and related industries. It seems that only a short while ago we were discussing Expo 2000 and now here we are fast approaching Expo 2001.

It gives us great pleasure to include a complimentary VIP Invitation with this newsletter to visit us at the show. This year, we will be in booth number 2459.

Be sure to stop by and see the latest advances in the Vis-U-Etch™ 5 and the VUE-Ferric.

PACKAGE DEALS AND SOMETHING FOR NOTHING

Let's say you needed to go to the store and purchase your food for the next week. Imagine that you walked into the store and the clerk said to you that they would take your list and bring back your groceries with no prices on them but your bill would be $100.00. Probably the first thing that would come to your mind is, "What are you trying to hide from me?" How can you know if you are getting a good price on anything when it is all lumped into one package?

This may sound completely ridiculous yet that is exactly the way many items are purchased in the PCB and related industries today. Some companies come in with package deals covering many processes and yet you have no idea how much each item is costing you.

On the surface, this may sound like a convenient solution. One call handles every process issue and you get one convenient bill for your accounting department to handle. The problems come later when you are able to start comparing the new costs associated with those processes to your old costs when you had separate pricing on each item. In most cases, people find out that they are spending a much higher price for the convenience of having one-stop, one-price purchasing. This usually happens six months later when they are well into their contract and get stuck with this deal for the remaining term.

What happens if one part of the package doesn't compare with the performance you used to get with a different product? Now you are stuck with the new product you don't like because it is part of your "convenient" package deal.

The best one is the line, "We'll include free equipment with this package." How much does this "free" equipment actually end up costing you? The first thought is that we don't have to come up with any up-front costs to purchase equipment.

Since we all know there really is nothing free in this world, how much does the equipment end up costing? If you ask the package deal people what the cost of the machine is, most will say it is covered in the chemistry. This is almost like saying, "Here is my paycheck, now take care of me."

This is not to say that all package deals are bad but you should have a few guidelines before going in to the deal.

- Is the company offering the package showing a break-down of the pricing of each item?
- How much is the value of any equipment being included and how long is the cost being amortized in the deal?
- If you don't like a particular process or product, what options are there to make changes?

As I said, not all packages are a bad deal. We have sold our equipment outright as well as including it in package deals but the most important thing is that the customer always knows the true costs and breakdown of the package components going into the deal.

Here is a good example of a package that included free equipment with the cupric replenisher that can really bring the point home. A customer of ours previously used a different system in a package deal. Based on the amount of chemistry they were using and the difference in cost between our chemistry and the competitor's chemistry, the "free" controller supplied with the competitor's chemistry was actually costing the customer over $90,000.00 per year!

If up front costs are a problem, there is also the option of purchasing the equipment through a bank loan or, even better, leasing the equipment with a buy out at the end of the lease. You'll want to talk with your leasing company first but you may find that the leasing option provides you with a much better tax advantage over an initial purchase.

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VOLATILITY IN ETCHANT CHEMISTRY

There are a great many PCB manufacturers making the switch from alkaline to cupric etchant these days to take advantage of the superior etch factor afforded by cupric. It is not fair, though, to say that all cupric is the same.

There are basically three different chemistries for regenerating cupric and two different control methods.

First, let's look at the regeneration chemistries:

- Chlorine gas
- Hydrogen peroxide
- Sodium Chlorate

Hydrochloric acid is used with all three.

Chlorine gas is becoming more and more scarce. This is due to many factors. On the surface, chlorine gas sounds the best because it has the lowest material cost but in practice, it has the highest cost. This is due to the extremely high initial setup cost and the required maintenance. There is also the liability of a chlorine gas release. All it takes is one sizeable release of chlorine gas and people can end up dead and the company is out of business or faced with high legal costs.

Hydrogen peroxide is used to combine with the hydrochloric acid present to produce the chlorine gas needed for regeneration. The problems associated with hydrogen peroxide lie in its lack of stability. First, peroxide is very flammable and precautions must be taken in its handling to prevent catching on fire. Many companies that have used peroxide have "exploding drum" stories. The lack of stability of peroxide also becomes apparent in the etchant regeneration process. As peroxide is added to the etchant, it reacts very quickly with the excess hydrochloric acid present and causes a sudden release of chlorine gas. This can be observed by the smell coming from the etcher, the rapid increase in ORP reading and the increase and decrease in etch rate and quality which makes this a very unstable etchant as well.

Sodium chlorate is also used to combine with the hydrochloric acid present to produce the chlorine gas needed for regeneration. Unlike peroxide, the liquid chlorate replenisher used at the PCB manufacturer is non-flammable as a liquid, making handling much safer. As chlorate is added to the etchant, it releases its oxygen more slowly than peroxide resulting in a slower rise in chlorine gas present in the etcher. This can even out the etch rate and quality fluctuations seen with peroxide. This results in a more stable etchant.

This leads me into the next and very important part. How you control the etchant is equally as important as which chemistry is used.

The two methods used for controlling etchant are:

- ORP/Normality/Specific Gravity
- Light transmission (Vis-U-Etch™ 5)

The first method uses an Oxidation Reduction Potential (ORP) probe to control oxidizer feeds, a conductivity (Normality) sensor to control hydrochloric acid feeds and water additions to control specific gravity. This all sounds very technical in nature but the big drawback of this type of control is the ***requirement*** for excess "free" acid in the etchant in order for the conductivity sensor to work properly. This poses a multitude of problems.

First, since you have a big pool of excess hydrochloric acid in the etchant, you have to be very cautious with your oxidizer feeds. Too much oxidizer and the excess chlorine gas released can not be used in the cuprous to cupric regeneration process and is now released into the atmosphere. This creates a very unhealthy environmental condition and the chlorine gas now attacks the quality of the panels and the material the etcher is made of.

Second, since the excess hydrochloric acid is always present, you are already constantly on the edge of a chlorine gas release. That makes it necessary to monitor this type of control very closely to prevent problems. Most people experience frequent chlorine gas releases with this type of control because of the excess hydrochloric acid present at all times which typically averages between 35-105 grams per liter of etchant.

This type of control can be used with chlorine gas, hydrogen peroxide or sodium chlorate. When used with chlorine gas, there is always the danger of a chlorine gas release into the room atmosphere. Due to the volatility of hydrogen peroxide, chlorine gas is also frequently released when it is used as the oxidizer. When sodium chlorate is used, the amount of chlorine gas released when over oxidized can even be greater because sodium chlorate releases its oxygen more slowly than peroxide. Therefore, when you do start to smell a chlorine gas release you have already added way too much sodium chlorate. Again, these chlorine gas events occur frequently because of the excess hydrochloric acid present.

The second method of control uses light transmission and is only found in the Vis-U-Etch™ 5. Using light transmission allows the etchant to operate with virtually no excess chemistry and this is what provides the most stable etchant. If there is virtually no free acid (=<0.04N), oxidizer can be fed into the etchant very quickly and safely because there is not enough free acid for it to react with. Consequently, if there is virtually no free oxidizer (2-5 grams/liter), acid can be fed into the etchant very quickly because there is not enough free oxidizer for it to react with.

Most people really can't believe just how stable the etchant becomes when the excess chemistry isn't there. As a typical example, we recently converted a high acid/hydrogen peroxide system controlled by ORP/Normality to a low acid/sodium chlorate Vis-U-Etch™ 5 system. The customer originally thought they had good control over the etchant with an average ORP range between 530mV and 580mV with frequent spikes between 700mV and 1000mV. After conversion to the Vis-U-Etch™ 5, the ORP stayed between 580-585mV during any twelve hour period tested. Now that's stability! And because there is no longer any free acid in the etchant, there is also no chlorine or hydrochloric acid smell. With no free acid, the ORP could be as high as 680-700mV before any chlorine gas is released into the atmosphere. This is what makes the light transmission Vis-U-Etch™ 5 system the favorite of so many companies. By not having a constant hydrochloric smell or frequent chlorine gas releases, etchant stability and safety are assured. The entire etch room atmosphere becomes much less corrosive resulting in longer equipment life and increased worker safety. Since zero-free acid etchant is the most stable of all systems, fine line capability and consistent high quality are always assured.