Micronutrients

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AdvantEdge 400 Series Replenisher (AdvantEdge 400 and AdvantEdge 400 TF)

Alkaline Etchant for Printed Circuit Boards

DESCRIPTION

AdvantEdge 400 series Replenishers are a newer generation of copper etchants designed for high volume production of printed circuit boards. AdvantEdge 400 series Replenishers offer excellent line width control, consistent etch rates and superior undercut protection.

AdvantEdge 400 series Replenishers has been formulated so that a tin-lead surface can be easily neutralized and brightened when processed through our etching solution. Refer to Product Specification sheet for specific product information.

RESIST COMPATIBILITY WITH AdvantEdge 400 series Replenishers:

Tin-Lead Solder	Nickel-Gold
Bright Solder	Gold
Tin	Most Dry Films
Bright Tin	Most Silk-screen Inks Formulated to Work w/ Alkaline Systems
Nickel	

Some alkaline strippable screen resists may be removed or softened in alkaline etchants. However, the relatively low operating pH of AdvantEdge 400 series Replenishers increases the ability of these resists to withstand the tendency to soften or be removed.

OPERATING PARAMETERS

Solution Makeup:	An AdvantEdge Starter solution, full strength
Solution Maintenance:	AdvantEdge 400 series Replenisher solution, full strength
Operating Temperature	110-130^{0}F (125^{0}F Optimum)
Operating Sp. Gr at 125^{0}F:	22-27^0 Baumé (23^0 Baumé Optimum)
Copper Concentration:	18-22 oz./gallon (20 oz./gallon Optimum)
Chloride Concentration:	4.7 – 5.5 mol/l
pH Range:	8.0-8.8
Etch Rate:	1.6 – 2.8 mil/min depending on temperature, type and model of etcher (avg 2.2 mil/min @ 125^{0}F)
Ventilation:	Connect to scrubber maintained at low pH (in accordance with local regulations

EQUIPMENT REQUIRED

The AdvantEdge 400 series Replenisher alkaline etchant system is designed for use in conveyorized spray etching equipment having thermostatic temperature controls and proper ventilation. The venting system must be capable of creating a slight negative pressure in order to confine ammonia fumes to the etch chamber. The use of a de-mister and a damper valve in the vent stack is recommended to prevent excessive loss of ammonia.

When venting is properly controlled in the entrance area of the etcher and the recirculating spray rinse attached, it is possible to maintain proper operating levels of all components. The function of the replenisher rinse is to minimize the copper salts on the circuit area and also reduce the copper concentration of drag out to the drain. There must be a water rinse after the replenisher rinse and before the use of the solder brightener solutions.

Etching equipment should be made of PVC or equivalent material. All metal in direct contact with the etchant solution should be made of titanium, including roller bars, heating and cooling coils. Quartz immersion heaters may also be used. Do not use stainless steel in contact with the AdvantEdge 400 series Replenisher or Starter Solution.

PERIODIC MAINTENANCE

1. Periodically pump etcher sump into a clean drum and rinse etch chamber with tap water.
2. Fill etch chamber with water and add 3 to 5% by volume of technical grade hydrochloric acid. Refer to the manufacturer's MSDS for specifics relating to hydrochloric acid.
3. Turn sprays on and allow this solution to spray for 10 to 15 minutes. Check the spray nozzle for blockage, clean if necessary, clean filter screens and replace. Clean out high-pressure lines to gauges and hydrometer stack.
4. Drain pump and rinse with tap water.
5. Repeat as required.
6. Replace with the appropriate AdvantEdge Starter Solution.
7. Note: rinse water should be managed in accordance with local regulations.

OPERATING INSTRUCTIONS

1. Charge etcher with the appropriate AdvantEdge Starter Solution.
2. Turn etcher heaters on. Do not turn the etcher sprays on.
3. When the etcher sump reaches operating temperature, turn on the sprays.
4. Turn on the power to the specific gravity control module, and set module switch to automatic.
5. Check the Baumé and set temperature to 125^{0}F. If it is in the operating range, you are now ready to etch boards.
6. Turn on exhaust fan and open damper valve in the vent stack just enough to prevent ammonia fumes from entering the adjacent work area. ***Do not over-ventilate***. Excessive loss of ammonia will cause the pH of the etching solution to drop below 8.0, with a resultant decrease in etch rate and potential sludge-out (precipitation) of copper.

CONTINUOUS OPERATION

1. Set conveyor speed control for the thickness of copper being etched.
2. Continue processing panels.
3. Periodically check:
   A. The replenisher source to prevent it from going dry.
   B. The spent storage drum to prevent overfill and spillage.
   C. The specific gravity at operating temperature.

TEMPORARY SHUTDOWN

1. Turn off etch spray pumps when boards are not being etched.
2. Switch control module to "OFF".

OVERNIGHT SHUTDOWN

1. Turn off etcher spray pumps.
2. Turn off AdvantEdge 400 series Replenisher control module.
3. Turn off heaters.
4. Close all vents.

DAILY MAINTENANCE

Check pH (8.0 to 8.8 at 125^{0}F) of the AdvantEdge 400 series Replenisher in the etcher. The operating pH will stabilize and should remain somewhat constant. However, changes in venting can dramatically change the pH. The pH should be checked daily; if fluctuations are noted showing a lower pH value than normal, refer to troubleshooting guide. When checking the pH of the solution, it is very important that the pH meter and electrodes be accurate and standardized before use. Standardize the pH meter regularly with a pH 7.0 buffer and crosscheck with a pH 10.0 buffer.

AdvantEdge 400 series Replenisher OPERATING RANGES

The AdvantEdge 400 series Replenisher system is best operated under the following parameter ranges:

Baumé:	22-27^0 (@ 125^{0}F.)
Copper:	18-22 oz/gal
Chloride	4.7 – 5.5 mol/l
pH:	8.0-8.8

TROUBLE SHOOTING GUIDE

The AdvantEdge 400 series Replenisher system is designed to work within certain balance limits of copper, chloride, ammonia (pH) and specific gravity (Baumé). Since most shops do not have the facilities to run a complete analysis, they operate on specific gravity and pH alone. What follows is intended to be a quick trouble-shooting guide for such operations. Extended problems would require both complete analysis and assistance from Micronutrients.

PROBLEM: Etching non-uniformity. Unetched copper in a line in the direction of the travel of the conveyor.

CAUSES:
1. Clogged or damaged nozzle.
2. Nozzle or spray branch not oriented properly (this applies to developer or etcher)
3. Spray bar oscillation not properly adjusted.

CORRECTION: Inspect nozzle and align nozzles and/or spray branches per etcher manufacturer recommendation. Adjust oscillation.

PROBLEM: Unetched copper in a line perpendicular to the direction of travel of the conveyor.
CAUSES: Conveyor not moving at a steady rate.
CORRECTION: Adjust conveyor.

PROBLEM: Unetched copper in corner or edges.
CAUSES: Excessive buildup of electroplated copper at edges of printed circuit board.
CORRECTION: Use additional robbers in the electroplating tank. Check current density. Increase border to blank off troublesome edges.

PROBLEM: Unetched copper along the outside edges of panel when etching the full width of the conveyor.

CAUSES:
1. Non-uniform impingement of etchant in these areas.
2. Spray bar oscillation not properly adjusted.

CORRECTION:
1. Add auxiliary nozzle, just sufficiently to remove excess copper.
2. Adjust spray bar oscillation.

PROBLEM: Excessive undercut. Generally first noticed when boards fail tape adhesion testing. In the extreme case, areas of circuitry are wiped out in etching.

CAUSES:
1. Problem with etch rate. Generally anything that will increase the etch rate will decrease the undercut.
2. If an etchant is being used with supplementary modifiers, they may be depleted or not present.

CORRECTION:
1. Increase pressure, temperature, or concentration of etchant.
2. Check with the supplier of the chemistry.

PROBLEM: Resist breakdown; copper etched in areas not intended.
CAUSES: Proper resist not specified or not properly applied or developed.
CORRECTION: Check with resist manufacturer.

PROBLEM: Resist flaking off; copper etched in areas not intended.
CAUSES: Poor adhesion of the resist due to improper cleaning of the copper surface.
CORRECTION: Check surface preparation.

PROBLEM: Etchant is breaking through the dry film resist that covers plated through-holes.
CAUSES:
1. Spray pressure too high.
2. Too much etchant impinging on a small area of board.
3. Too thin a dry film is being used.

CORRECTION:
1. Use lower pressure.
2. Use a spray nozzle that spreads the spray over a wider area.
3. Check with the dry film manufacturer.

PROBLEM: Slow etch rate; unetched copper on entire surface.
CAUSES:
1. Etchant depleted.
2. Low pressure.
3. Low temperature.
4. Etchant chemistry out of control (e.g. copper content too low).
5. Conveyor speed too fast.
6. Solution sludging out.

CORRECTION:
1. If regenerative or steady state process, check equipment.
2. Increase pressure.
3. Increase temperature.
4. Analyze etchant and adjust.
5. Adjust conveyor.
6. Refer to section on sludging.

PROBLEM: Solution sludging out often goes hand in hand with slow etch rate. Sludge is a fine light, powder blue color.
CAUSES:
1. Dilution of sump with water.
2. High copper concentration.
3. pH of etch too low (e.g. 8.0 or lower)

CORRECTION:
1. Check for leaks (cooling coils; excessive water on boards; crack in wall between etching & rinsing); add ammonia to the sump to solubilize the sludge
2. Check the specific gravity controller function; may need to lower set point.
3. Raise pH
    - Damper the exhaust (excessive venting)
    - Add replenisher solution or aqua ammonia
    - Add ammonia

PROBLEM: Under etched; copper remaining at the edge of circuit or between fine lines.
CAUSES:
1. Under developed (see causes for slow etch rate)
2. Etchant temperature too low.

CORRECTION:
1. Check developing process.
2. Set temperature to recommended range.

PROBLEM: Over etched; excessive etching under the resist edges.
CAUSES:
1. Pressure too high.
2. Temperature too high.
3. Conveyor speed too low.
4. Etchant chemistry out of control.
5. Baumé of etchant may have been reduced by the unintentional addition of water.

CORRECTION:
1. Adjust pressure.
2. Adjust temperature
3. Adjust conveyor speed.

4. Analyze and adjust.
5. Check cooling coil for leaks and spray rinses for overspray. Adjust to desired specific gravity.

PROBLEM: Spotty etching; copper plating is uneven. Etchant cannot be selective.
CAUSES: Pre-etch cleaning is insufficient.
CORRECTION:
1. Alkaline residue from dry film resist stripper solution must be thoroughly cleaned prior to etch. Some shops have installed automatic spray stripping and cleaning equipment in-line with etcher.
2. Contaminants from handling (e.g. finger prints) or copper oxide from atmosphere must be cleaned off prior to etch.

PROBLEM: Dark solder. Usually first noticed in ground plane or thief areas as a darkening of the usually light deposit. May appear light in the area adjacent to the dry film and darker as you move from this area.
CAUSES:
1. High chloride level in etcher.
2. pH of etch too low (e.g. 8.0 or lower)
3. High copper concentration and low pH.
4. High chloride concentration and low pH.
5. Poor rinsing of etchant.

CORRECTION:
1. Lower chloride level
    - Damper the exhaust (excessive ventilation)
    - Add replenisher solution or aqua ammonia
    - Add ammonia
2. Raise pH
    - Damper the exhaust (excessive ventilation)
    - Add replenisher solution or aqua ammonia
    - Add ammonia
3. Adjust copper by lowering Baumé while raising pH by adding the replenisher solution or aqua ammonia (run on manual control)
4. Raise the pH by adding ammonia. This will lower the chlorides by the dilution effect (run on manual control)
5. Make sure the water pressure and flow through nozzles are okay. If boards show evidence of light, powder blue color, add ammonia to flood rinse or sump.

PROBLEM: Copper crystallization; crystals are hard, deep blue in color and often plug the spray nozzles.
CAUSES:
1. pH of etch too low (e.g. 8.0 or lower)
2. High chloride level in etcher.
3. High copper concentration in etcher.

CORRECTION:
1. Raise pH
    - Damper the exhaust (excessive ventilation)
    - Add replenisher solution or aqua ammonia
    - Lower copper set point
2. Add ammonia
3. Lower the copper level by lowering the copper set point on the controller

When analysis of chloride and copper are available, the following table will help to diagnose possible causes of low etch rate.

Condition of Etching Solution				
Copper	**Chloride**	**pH**	**Probable cause of reduced etch rate**	**Corrective action**
Normal	Normal	Normal	Low temperature	Check temperature with thermometer and adjust thermostat.
Normal	Normal	Normal	Reduced spray pressure	Examine pressure gauges and observe spray patterns. Clean pump intake screens. Remove and clean spray nozzles, if necessary.

Condition of Etching Solution				
Copper	**Chloride**	**pH**	**Probable cause of reduced etch rate**	**Corrective action**
Normal	Low	Low – below 8.0	Excessive ventilation	Add 26° Baumé aqua or anhydrous ammonia to a pH above 8. Reduce ventilation.
Normal or Low	Low	High – above 8.8	Dilution with water	Add replenisher (up to 10% of etcher sump volume). Pump rate 0.5 gallon per minute. Check for water leaks in cooling coils or from rinse chamber.
Low – below 18 oz	Low	Normal	Dilution with water or automatic replenishment equipment jammed "on" (over-replenished)	Replace etching solution with fresh starter. Check for water leaks and automatic replenishment equipment malfunction.
High – above 22 oz	High	Low – below 8.0	Automatic replenishment equipment jammed "off" (under-replenished)	Correct Baumé with replenisher addition. Check automatic replenishment equipment for malfunction.
Low	Normal	Normal	Automatic replenishment equipment jammed "on" (over-replenished)	Dissolve copper to raise Baumé. Check automatic replenishment equipment for malfunction.
High – above 22 oz	Low	High – above 8.8	Automatic replenishment equipment jammed "off" (under-replenished)	Correct Baumé with replenisher addition. Check automatic replenishment equipment for malfunction.
Normal or Low	Low	High	Frozen replenisher	Raise replenisher temperature to 70°F and agitate for 20 minutes. Check storage containers for precipitant.

A FEW ITEMS OF NOTE

1. When making additions -- particularly ammonia -- the controller should be shut off. Ammonia will lower the Baumé drastically.

2. Additions of any component should always be made gradually so as not to shock the system totally out of balance.

3. The relationship between Baumé and specific gravity is as follows:

   Degree Baumé = 145 - (145 ÷ Specific Gravity)

   (Therefore a liquid with a specific gravity of 1.000 has a Baumé of 0.00).

4. The specific gravity of aqueous ammonia (26 Bé) is 0.897. Baumé for liquids of density less than 1.000 is calculated as:

   Degree Baumé = (145 ÷ Specific Gravity) - 130

CAUTION

Adequate ventilation must be provided on the etching equipment in which AdvantEdge Starter and Replenisher solutions are used. A strong ammonia odor is released when either of the solutions are agitated. General room ventilation is also recommended. Avoid contact of the AdvantEdge Starter and Replenisher with eyes and skin. Safety goggles and protective clothing should be worn when handling the products. If contact should occur, apply copious amounts of cold water to the effected area and get medical attention. Any spillage of these materials should be washed with large amounts of water. Refer to the MSDS for AdvantEdge Starter and Replenisher.

PACKAGING AND STORAGE

AdvantEdge Starter and Replenisher solutions are available in 55-gallon drums. AdvantEdge 400 series Replenisher solution is also available in bulk tanker shipments and 300-gallon totes. These chemical products can be stored over extended periods of time in their original drums if placed in a protected, ventilated area with a temperature range between 50 - 90^{0}F.

SPENT ETCHANT

All spent etchant must be returned to Micronutrients at the time of delivery of the replenisher and must contain a minimum of 16 oz/gal of copper.

WARRANTY

The quality of this product is guaranteed on shipment from our plant. If the use recommendations are followed, desired results should obtained. Since the use of our products is beyond our control, no guarantee expressed or implied is made as to the effects of such use, or the results to be obtained.