COPPER GLEAM™ CuPulse
Copper Plating Process

For PWB Metallization Applications

Regional Product Availability

- N.America
- Japan/Korea
- Asia
- Europe

Description

The COPPER GLEAM™ CuPulse Process was designed for copper plating of printed circuit boards using PPR current. The combination of the CuPulse formulation and optimized PPR waveforms can dramatically reduce acid copper plating times compared to traditional DC electroplating. These productivity gains are made while maintaining excellent physical properties and the reliability of the copper deposit. The COPPER GLEAM CuPulse Process is especially suited for reducing cycle times on thick-panel, high-aspect ratio designs.

Advantages

- Unsurpassed performance on thick-panel, high-aspect ratio applications
- Stable, consistent plating performance over the lifetime of the bath
- Novel analytical methods help the process remain in control and at the enhanced set points during operation—the analytical procedures are quick and simple to run
- Excellent through-hole leveling performance

Advantages Over Conventional DC Systems

- Reduced plating cycles for a wide range of product difficulties, board thickness and hole diameters
- Excellent surface-to-hole deposit thickness ratio/throwing power
- Uniform deposit thickness from the top of the hole to the center of the hole—no “dog bone-shaped” holes
- Excellent performance on blind-vias—laser or controlled depth drilled and mixed-technology designs

Make-up Quanitites for 100 gallon (100 liter) tank size		
Component	Metric (100 liters)	U.S. (100 gallons)
Electronic Grade Copper Sulfate ($CuSO_4$•$5H_2O$) or Liquid Copper Sulfate (270 g/L [36 oz./gal.] $CuSO_4$•$5H_2O$)	8 kg or 30 liters	67 lbs. or 30 gallons
Sulfur-free Carbon (Norit RO 0.8)*	0.36–0.6 kg*	3–5 lbs*
C.P. Grade Concentrated Sulfuric Acid**	12.2 liters	12 gallons
C.P. Grade Concentrated Hydrochloric Acid*	Add only based on analysis*	Add only based on analysis*
CuPulse Additive A	22 ml	80 ml
CuPulse Carrier C	1.5 liters	1.5 gallons
Deionized (D.I.) Water	To volume	To volume

* See Bath Make-up Procedure for details.
** It is recommended that more dilute forms of sulfuric acid be used with corresponding adjustments in volume.

Bath Make-Up Procedure

1. Please refer to the appropriate procedures for the correct preparation of the tank, anodes, filters, anode bags and other related items. Do not proceed until tank has been cleaned and leached according to the supplied procedure.
2. Fill the tank to approximately 1/3 (33%) of the final bath volume with D.I. water.
3. Add the copper sulfate liquid or copper sulfate crystals and mix well.
4. SLOWLY, with thorough mixing, add the sulfuric acid. CAUTION! The sulfuric acid disassociation reaction is exothermic. Heat is generated. A dangerous condition can result if the sulfuric acid is not added slowly with thorough mixing. It is recommended that more dilute forms of sulfuric acid be substituted with corresponding adjustments in volume.
5. Bring the solution to approximately 2/3 (66%) of the final volume with D.I. water. Turn on the circulation, filtration and solution agitation. Cool solution to 100°F (38°C) or below before proceeding to the next step.
6. Place pre-bagged anodes (see anode preparation guidelines) into tank and fill to final volume with D.I. water.
7. Analyze the solution for copper sulfate and sulfuric acid and adjust as necessary.
8. Circulate the solution through a carbolator containing pre-rinsed, activated carbon at an approximate loading of 3–5 lbs./100 gallons (0.36–0.6 kg/100 liters)of bath. Activated carbon filters may be substituted if a carbolator is not available. Circulate for 4–6 hours.
9. Continue to circulate the solution through activated carbon until the bath stability index is less than 3 units. Replace the carbon charge (or filters) every 4–6 hours during this process.
10. When carbon polishing is complete, install the pre- leached wound filters (previously prepared according to the procedures in this document). In a separate chamber, install carbon filters at a loading of 10 inches of carbon filter per 100 gallons (379 liters) of bath volume.

Note: DO NOT mix carbon and wound filters in the same filter chamber(s).

For larger tanks, alternate methods of carbon polishing may be required—in these cases see the process manual for more details.

11. Analyze solution for chloride and adjust to 32 ppm.

Note: for 100 gallons of bath.

8.3 mL of concentrated hydrochloric acid (37%) = 10 ppm chloride

Note: for 100 liters of bath.

2.2 mL of concentrated hydrochloric acid (37%) = 10 ppm chloride

Dummy Plate Procedure

The dummy plate procedure is designed to properly film the anodes and to allow time to stabilize the feed rate of the CuPulse Additive A component. The dummy plate procedure requires the use of clean, scrubbed copper-clad laminate cathodes. The anode to cathode area should not exceed 1:1 during the dummy plate procedure.

1. Determine the amount of copper-clad laminate required to provide a total cathode area equal to approximately 0.75 times the total anode area.
2. Deburr, rack and thoroughly clean the copper-clad laminate.

Note: if one-sided contact racks are used, the two copper sides of the laminate must be connected using copper tape, or the laminate must be plated with electroless copper.

3. Dummy plate according to the following schedule:

Note: Do not add the CuPulse Additive A or CuPulse Carrier C components until specified.

Dummy Plate Schedule		
Waveform	Cathode Current Density	Duration
DC	2.5 ASF (0.25 ASD)	2 hours
DC	5 ASF (0.5 ASD)	2 hours
DC	10 ASF (1.0 ASD)	2 hours
Check chloride and replenish to 32 ppm before coninuing with the dummy prodecure		
Check Stability Index and make sure it is below 3 units before proceeding; add the approximate amount of CuPulse Carrier C to the bath before continuing with the dummy procedure		
DC	10 ASF (1.0 ASD)	4 hours
Fwd/Rev CD = 1:2 Fwd time = 50 ms Rev time = 2 ms	10 ASF (1.0 ASD)	2 hours

4. Analyze chloride and replenish to 32 ppm.
5. Add the appropriate amount of CuPulse Additive A to the bath at this point.
6. Pre-clean new copper-clad cathodes according to steps 1 and 2.
7. Dummy plate using the new copper-clad cathodes according to the following schedule, using an initial feed rate for CuPulse Additive A of 0.37 mL/A-hr. The Additive component should be analyzed and maintained between 0.18–0.26 mL/L.

Dummy Plate Schedule		
Waveform	Cathode Current Density	Duration
Fwd/Rev CD = 1:2 Fwd time = 50 ms Rev time = 2 ms	10 ASF (1.0 ASD)	4 hours

8. Analyze and replenish the CuPulse Additive A, CuPulse Carrier C and chloride.

Additional dummy plating may be required to stabilize the feed rate of the CuPulse Additive A component. It is normal for the required Additive A feed rate to drop over time, especially early in the life of the new make- up bath.

Dummy plating in pulse mode is also recommended in place of idle time whenever feasible over the life of the bath. This will improve the stability of the bath upon production start-up.

Bath Operation		
Component	Range	Recommended
Copper Sulfate ($CuSO_4$•$5H_2O$)	70–90 g/L	80 g/L
Sulfuric Acid	215–235 g/L	225 g/L
Chloride Ion	30–35 ppm	32 ppm
CuPulse Additive A	0.18–0.26 mL/L (0.018–0.026% v/v)	0.22 mL/L (0.022% v/v)
CuPulse Carrier C	12–20 mL/L (1.2–2.0% v/v)	15 mL/L (1.5% v/v)
Temperature	72–80°F (22–27°C)	77°F (25°C)
Peak Fwd Current Density	5–20 ASF (0.5–2.0 ASD)	Depending on product type
Air Agitation	Medium to high air sparging	Medium-high
Paddle Agitation	1–3 in./stroke 10–15 strokes/min.	2 in./stroke 12 strokes/min.
Anode to Cathode spacing	8–12 inches	12 inches
Anode to Cathode area ratio	1:1–1.5:1	Depends upon operating current density
Anode current density	8–20 ASF	Not to exceed 20 ASF
Vibration-continuous	0.5–1.5 in./sec.	1.0 in./sec.

Bath Control

Replenishment

CuPulse Additive A and CuPulse Carrier C are actively consumed during plating and through passive means during idle periods. After an idle period of one shift or more the bath should be dummy plated at 10 ASF (1.0 ASD) for ½ hour prior to analysis and any replenishment. Detailed shutdown procedures can be found in the CuPulse process manual. CuPulse Additive A should be analyzed approximately twice per shift. CuPulse Carrier C should be analyzed once every 2 days. The analytical procedures are detailed in the CuPulse process manual. Consistent replenishment is best achieved through an A-hr based automatic dosing system.

Inorganic components should be analyzed and replenished twice per week. The chloride concentration should be checked daily.

Deposit Properties

Grain Structure*:	Holewall – fine-grained equiaxed Surface – transition to columnar
Board Appearance*:	Optimum – satin white surface w/ bright holes Range – bright to matte red
Density:	8.9 g/cm^3
Conductivity:	0.59 mega S/cm (0.59 megamho/cm)
Elongation:	15–30%**
Tensile Strength:	250–350 N/mm^2 (36–50 kpsi)
Hardness:	180–220 Knoop (as deposited) 80–120 Knoop after 2–4 days at room temperature or 1–2 hours at 100°C (212°F)
Solderability:	Excellent
Purity:	99.9%+ pure copper

*wave dependant
**Tested in accordance with IPC-TM-650-foil thickness 2.0 mil (50 micron)

Product Data

CuPulse Additive A

Appearance:	Clear, pale blue liquid
pH:	3.0–5.0

CuPulse Carrier C

Appearance:	Clear, pale blue liquid
pH:	3.0–5.0

Equipment Requirements

The general equipment requirements for the CuPulse bath are similar to many DC and PPR plating systems.

Tanks:	Temperature-stabilized polypropylene, PVC
Heaters:	Teflon fluoropolymer-coated heaters with thermostatic control
Anodes:	0.04% to 0.08% phosphorized, deoxidized copper balls/nuggets/chunks in suitablysized titanium anode baskets
Anode bags:	Polypropylene anode bags
Regular Filtration:	Continuous filtration through cleaned 5 micron polypropylene cartridges with a bath turnover of three to five times per hour
Carbon Filtration:	Dedicated continuous carbon filtration; 10 inches of carbon filter per 100 gallons of bath 100% of the carbon filters should be changed every two weeks; large tank volumes may require granular carbon purification systems—see process manual for details
Rectification:	Periodic Pulse Reverse rectification
Vibration:	Continuous vibration capable of producing 1.0 in./sec.

The pulse reverse rectifier should be capable of producing a square waveform. The reverse current capacity should be 2–4 times the forward current. The forward pulse duration capability should be from 10–50 msec, with a reverse pulse duration capability of 0.3–3.0 ms. The forward current capacity required is dependant upon the specific customer application.

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Equipment Preparation

Please follow the process manual for detailed instructions for equipment preparation.

Tank Preparation

New tanks or product conversions

When using any new equipment or when converting from another plating bath, tanks and all piping with circulation system must be cleaned and leached prior to installation of the CuPulse chemistry. Proper tank leaching involves several steps and solutions. Ensure that during each step all the cleaning, leaching and rinse solutions come in contact with any parts of the tank and peripheral equipment that will eventually contact the plating solution.

This requires purging each solution through all air spargers, pumps and filter chambers that may be in use at any time during the lifetime of the bath.

Leaching Procedure

1. Completely remove old plating solution from the tank.
2. Remove the anode baskets from the tank.
3. Clean any debris from the tank, then rinse the tank and all equipment with clean water and drain.
4. Fill tank with water and circulate the solution through the complete system for 30 minutes and drain.
5. Fill the tank with 4 oz./gal. sodium hydroxide (or 5% bv of 50% sodium hydroxide liquid or 5 oz./gal. trisodium phosphate), heat to 100–110°F (40–45°C) and circulate through the entire system for a minimum of 4 hours.
6. Drain the tank completely, then rinse the tank and all equipment with clean water and drain.
7. Fill the tank with clean water and circulate through the entire system for 1 hour.
8. Drain the tank completely, then rinse the tank and all equipment with clean water and drain.
9. Fill the tank with 100 mL/L (10%v/v) sulfuric acid solution. Circulate through the entire system for a minimum of 8 hours.
10. Drain the tank completely, then rinse the tank and all equipment with clean water and drain.
11. Fill the tank with clean water and circulate through the entire system for 1 hour.
12. Drain the tank completely, then rinse the tank and all equipment with D.I. water and drain.

Anode Preparation

Anode Bag Preparation

1. Do not reuse anode bags—only use new anode bags.
2. Separate anode bags and wash thoroughly using hot water until no foam/sizing is observed.
3. Soak the anodes for a minimum of 1 hour in a 10% solution of sulfuric acid.
4. Rinse the bags thoroughly in D.I. water.

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New Anodes Procedure

1. Microetch copper anodes using a sodium persulfate or peroxide sulfuric microetch until they are no longer shiny and have a uniform matte pink appearance.
2. Rinse the anodes well.
3. Fill the titanium anode baskets with the anodes. Ensure that the anode baskets are completely filled with the anode balls or nuggets.
   Note: when in the tank, the anode baskets should extend a minimum of 1–2 inches above the solution level with the air agitation on.
4. Place anode baskets into previously leached anode bags.
5. Immerse anodes/baskets/bags in a 10% (v/v) sulfuric acid solution for 3 minutes.
6. Place the anodes in the appropriate positions within the acid copper tank.

Used Anodes Procedure

1. Remove and thoroughly rinse existing anodes.
2. Remove and discard the anode bags from the existing anode baskets.
3. Sort nuggets and discard small nuggets.
4. Microetch remaining copper anodes using a sodium persulfate or peroxide sulfuric microetch until they are fully cleaned and have a uniform matte pink appearance. No black anode film should remain.
5. Rinse the anodes thoroughly with D.I. water.
6. Fill the bottom third of the anode baskets with previously etched new anode material (not the used material from above).
7. Top off using the larger used material from above.
8. Place anode baskets/anodes into previously leached anode bags.
9. Immerse the anodes in a 10% (v/v) sulfuric acid solution for 3 minutes.
10. Place the anodes in the appropriate positions of the acid copper tank.

Filter Cartridge Preparation

Polypropylene Filter Cartridge Leaching Procedure

1. Wash/flush the cartridges thoroughly with hot water.
2. Rinse well until there is no foam/sizing.
3. Leach the cartridges with 10% v/v sulfuric acid for a minimum of 1 hour.
4. Rinse thoroughly with D.I. water.

Carbon Filter Cartridge Leaching Procedure

Carbon filters do not typically require leaching prior to use. Please see the process manual for additional recommendations regarding carbon filtration.

Handling Precautions

Before using this product, or the analytical reagents required for this control, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on material hazards, recommended handling precautions and product storage.

CAUTION! Keep combustible and/or flammable products and their vapors away from heat, sparks, flames and other sources of ignition including static discharge. Processing or operating at temperatures near or above product flashpoint may pose a fire hazard. Use appropriate grounding and bonding techniques to manage static discharge hazards.

CAUTION! Failure to maintain proper volume level when using immersion heaters can expose tank and solution to excessive heat resulting in a possible combustion hazard, particularly when plastic tanks are used.

Storage

Store products in tightly closed original containers at temperatures recommended on the product label.

Disposal Considerations

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Dow Electronic Materials Technical Representative for more information.

Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take approp riate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products - from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

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Contact:
North America: 1-800-832-6200
Japan: (+81) 3-5460-4696
Asia: (+852) 2680-6888
Europe: (+41) 41-259-44-44
http://www.dow.com

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