Copper Gleam PC is an acid copper plating process designed to produce stable, bright, ductile copper deposits. It can be used for low speed applications such as electroforming, barrel plating or through hole plating of printed circuit boards. Copper Gleam PC can also be used in high speed mode, specifically for reel-to-reel and jet plating applications. The process uses a single additive with easy process control and is economical in use. Frequent carbon purification is not normally required. Deposits withstand thermal shock tests to BS9760.

Copper Gleam PC is also excellent for barrel bright copper strike plating of beryllium copper and phosphor bronze components.

**OPERATIONAL DATA**

**Low Speed – Rack or Normal Barrel Operation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulphate (CuSO₄ • 5 H₂O)</td>
<td>60 - 90 g/l</td>
<td>75 g/l</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>160 – 220 g/l</td>
<td>180 g/l</td>
</tr>
<tr>
<td>Chloride ion (Cl⁻)</td>
<td>40 - 80 ppm</td>
<td>70 ppm</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>1.5 – 4.0 ml/l</td>
<td>2.5 ml/l</td>
</tr>
<tr>
<td>Temperature</td>
<td>23 - 32°C</td>
<td>27°C</td>
</tr>
<tr>
<td>Cathode current density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rack</td>
<td>1.5 – 4.0 A/dm²</td>
<td>2.5 A/dm²</td>
</tr>
<tr>
<td>Barrel</td>
<td>0.1 - 0.5 A/dm²</td>
<td>0.25 A/dm²</td>
</tr>
<tr>
<td>Anode current density</td>
<td>1 - 3 A/dm²</td>
<td>As high as possible.</td>
</tr>
<tr>
<td>Agitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate air agitation and mechanical movement. For printed circuits 1 metre / minute cathode rod movement plus vibration is recommended.</td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>0.5 micron per minute at 2.5 A/dm²</td>
<td></td>
</tr>
</tbody>
</table>
### Barrel Strike Operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulphate (CuSO₄ • 5 H₂O)</td>
<td>25 - 35 g/l</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Sulphuric acid (S.G. 1.84)</td>
<td>200 – 250 g/l</td>
<td>220 g/l</td>
</tr>
<tr>
<td>Chloride ion (Cl⁻)</td>
<td>50 - 70 ppm</td>
<td>60 ppm</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>1.5 – 4.0 ml/l</td>
<td>2.5 ml/l</td>
</tr>
<tr>
<td>Temperature</td>
<td>23 - 32°C</td>
<td>27°C</td>
</tr>
<tr>
<td>Cathode current density</td>
<td>0.1 - 0.5 A/dm²</td>
<td>0.25 A/dm²</td>
</tr>
<tr>
<td>Anode current density</td>
<td>1 - 3 A/dm²</td>
<td>As high as possible.</td>
</tr>
<tr>
<td>Agitation</td>
<td>Moderate air agitation and barrel rotation.</td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>0.05 micron per minute at 0.25 A/dm²</td>
<td></td>
</tr>
</tbody>
</table>

### Electroforming Applications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulphate (CuSO₄ • 5 H₂O)</td>
<td>140 - 160 g/l</td>
<td>150 g/l</td>
</tr>
<tr>
<td>Sulphuric acid (S.G. 1.84)</td>
<td>160 – 220 g/l</td>
<td>180 g/l</td>
</tr>
<tr>
<td>Chloride ion (Cl⁻)</td>
<td>40 - 80 ppm</td>
<td>70 ppm</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>5 – 10 ml/l</td>
<td>7.5 ml/l</td>
</tr>
<tr>
<td>Temperature</td>
<td>23 - 32°C</td>
<td>27°C</td>
</tr>
<tr>
<td>Cathode current density</td>
<td>1.5 – 5.0 A/dm²</td>
<td>3.0 A/dm²</td>
</tr>
<tr>
<td>Anode current density</td>
<td>1 - 3 A/dm²</td>
<td>As high as possible.</td>
</tr>
<tr>
<td>Agitation</td>
<td>Moderate air agitation and mechanical movement.</td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>0.6 micron per minute at 3 A/dm²</td>
<td></td>
</tr>
</tbody>
</table>

### Medium to High Speed Operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulphate (CuSO₄ • 5 H₂O)</td>
<td>260 - 320 g/l</td>
<td>290 g/l</td>
</tr>
<tr>
<td>Sulphuric acid (S.G. 1.84)</td>
<td>18 - 55 g/l</td>
<td>36 g/l</td>
</tr>
<tr>
<td>Chloride ion (Cl⁻)</td>
<td>40 - 80 ppm</td>
<td>70 ppm</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>5 – 50 ml/l</td>
<td>(see Notes 2 &amp; 3)</td>
</tr>
<tr>
<td>Temperature</td>
<td>21 - 50°C</td>
<td>27°C</td>
</tr>
<tr>
<td>Cathode current density</td>
<td>5 – 30 A/dm²</td>
<td>(see Notes 2 &amp; 3)</td>
</tr>
<tr>
<td>Anode current density</td>
<td>1 - 3 A/dm²</td>
<td>As high as possible.</td>
</tr>
<tr>
<td>Agitation</td>
<td>Vigorous solution plus work piece movement.</td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>2 microns per minute at 10 A/dm² under all normal operating conditions</td>
<td></td>
</tr>
</tbody>
</table>
DEPOSIT DATA

Copper Semi-lamellar copper of high purity with excellent over-plating and soldering properties
Density $8.9 \text{ g/cm}^3 : 0.89 \text{ mg/cm}^2 = 1 \text{ micron}$
Conductivity 0.59 megamho/cm
Hardness 180 - 220 VPN falling to ca. 100 - 120 VPN after 1 hour at 100°C or ca. 3 days at room temperature.
Internal Stress ca. 100 kg/cm$^2$ tensile

SOLUTION MAKE UP FOR 1 LITRE – RACK OR BARREL OPERATION

<table>
<thead>
<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purified Liquid Copper Sulfate</td>
<td>250 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>500 ml</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.1 g *</td>
</tr>
<tr>
<td>Sulphuric acid 65 % BP Grade (S.G. 1.55)</td>
<td>180 ml</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>2.5 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>To make one litre</td>
</tr>
</tbody>
</table>

SOLUTION MAKE UP FOR 1 LITRE – BARREL STRIKE OPERATION

<table>
<thead>
<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purified Liquid Copper Sulfate</td>
<td>100 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>600 ml</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.1 g *</td>
</tr>
<tr>
<td>Sulphuric acid 65 % BP Grade (S.G. 1.55)</td>
<td>220 ml</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>2.5 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>To make one litre</td>
</tr>
</tbody>
</table>
SOLUTION MAKE UP FOR 1 LITRE – ELECTROFORMING APPLICATIONS

<table>
<thead>
<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purified Liquid Copper Sulfate</td>
<td>500 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>250 ml</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.1 g *</td>
</tr>
<tr>
<td>Sulphuric acid 65% BP Grade (S.G. 1.55)</td>
<td>180 ml</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>2.5 ml</td>
</tr>
<tr>
<td>Deionised water</td>
<td>To make one litre</td>
</tr>
</tbody>
</table>

Copper sulphate can vary according to speed and component geometry (higher copper sulphate permits higher current densities but with lower throwing power) and care must be exercised to avoid excess total sulphate otherwise copper sulphate will precipitate randomly due to common ion effect. The higher initial addition of Copper Gleam PC Additive is in order to reduce internal stress of thick deposits to near zero. Replenishment should be close to normal bulletin recommendations for both barrel and electroforming.

SOLUTION MAKE UP FOR 1 LITRE – MEDIUM TO HIGH SPEED OPERATION

<table>
<thead>
<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purified Liquid Copper Sulfate</td>
<td>970 ml</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.1 g *</td>
</tr>
<tr>
<td>Sulphuric acid (S.G. 1.84)</td>
<td>20 ml</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
<td>medium speed (5 - 20 A/dm²) 5 - 10 ml 5 - 20 A/dm²</td>
</tr>
<tr>
<td></td>
<td>high speed (21 - 300 A/dm²) 10 - 50 ml (see notes 2 &amp; 3)</td>
</tr>
</tbody>
</table>

Make up procedure

1. Use only Purified Liquid Copper Sulfate supplied by Rohm and Haas EM which contains 300 g/l copper sulphate. Add the required volume of Purified Liquid Copper Sulfate to a clean tank.

2. Add the required volume of deionised water depending on the formulation required.

3. Carefully add the required volume of sulphuric acid whilst stirring the solution to avoid localised overheating and spattering. Allow the solution to cool to below 30°C. Note that the use of Sulphuric acid 65% BP Grade (S.G. 1.55) is recommended whenever possible. However due to volume restrictions sulphuric acid (S.G. 1.84) must be used for medium speed and high speed solutions. Caution: Suitable protective clothing, gloves and safety glasses must be worn at all times when working with acid copper plating solutions.
4. Add the required volume of Copper Gleam PC Additive and dilute to final volume with deionised water as required.

5. Allow the solution to mix thoroughly then determine the chloride ion concentration.

6. * Add the precise quantity of sodium chloride to raise the chloride ion concentration to 80 ppm (see note 4).

7. When copper anodes are used, electrolyse the solution at 5 A/dm² until a minimum of 2 ampere-hours / litre has elapsed. The solution is now ready for use.

**EQUIPMENT**

- **Tanks** Temperature-stabilised translucent white polypropylene lined.
- **Anodes** Phosphorus deoxidised copper (0.03 – 0.08% P), anode bars or slugs in titanium baskets, bagged with woven polypropylene.
  
  In high speed reel-to-reel equipment platinised titanium mesh may be used (see note 1).
- **Heaters** PTFE with thermostat control.
- **Filtration** Preferably continuous using 5 micron woven polypropylene cartridges with a flow rate of ca. three times tank volume / hour.
- **Electrical** 4 - 16 volt stabilised DC supply (maximum ripple 5%) with preference for stepless control and ampere-hour meter.
- **Fume extraction** Recommended

**SOLUTION MAINTENANCE**

**Replenishment** For low speed operation ca. 200 – 300 ml Copper Gleam PC Additive per 1000 Ampere-hours.

In high speed mode ca 250 - 1000 ml Copper Gleam PC Additive per 1000 Ampere-hours, dependent on operation (see notes 1 and 2).

**ANALYSIS**

Prior to sampling, the bath volume must be adjusted to operating level with deionised water and thoroughly mixed.

Using copper, sulphuric acid, chloride and Copper Gleam PC Additive determinations, make appropriate adjustments according to the Replenishment Schedule.
NOTES

1. When platinised titanium anodes are used in high speed reel-to-reel equipment, the additive consumption will be significantly higher than when copper anodes are used. Furthermore the solution will have a finite life because of the build up of sulphate ion from continued replenishment of copper sulphate.

2. Maximum deposition speed at current densities of greater than 30 A/dm$^2$ is only normally feasible in jet plating equipment. For maximum speed the temperature can be raised up to 50°C but at temperatures above 35°C additive consumption will be increased significantly. For maximum economy operate the solution at the lowest possible temperature above 21°C to achieve the desired current density range. For given solution conditions an increase in Copper Gleam PC Additive content will increase the current density range.

3. The amount of Copper Gleam PC Additive required for the make up of a new solution depends on the proposed current density. For medium speed operation 5 - 20 A/dm$^2$, 5 - 10 ml/l is normally sufficient and for high speed operation (with very vigorous agitation) 21 - 300 A/dm$^2$, 10 - 50 ml/l should be added in 10 ml/l increments until the desired level of brightness is achieved.

4. 0.016 g/l sodium chloride will increase the chloride ion concentration by 10 ppm.

5. High chloride levels can cause anode polarisation. Consult Rohm and Haas customer service laboratories for recommendations to remove chloride.

6. Very low anode surface area, operating anodes in titanium baskets and any other effects that produce anode polarisation will always increase additive consumption. In extreme cases this can even cause rough deposits.
When ordering please use the following product descriptions:

<table>
<thead>
<tr>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purified Liquid Copper Sulfate</td>
</tr>
<tr>
<td>Copper Gleam PC Additive</td>
</tr>
</tbody>
</table>

Electroplating chemicals and specialities can be corrosive, harmful and poisonous. Care should be taken with respect to appropriate storage, handling and utilisation. When disposing such chemicals, the regulations regarding the treatment of waste water are to be strictly observed.

Date: February 2007
Issue: 1
Supersedes: Previous Copper Gleam PC and High Speed Copper Gleam data sheets.