PALLAMET™ 600 Palladium-Nickel
Low Ammonia Alloy Electroplating Solution
For Electronic Applications

Regional Product Availability
• North America
• Japan/Korea
• Asia
• Europe

Description
PALLAMET™ 600 Palladium-Nickel is a new generation of chloride-free, palladium-nickel electroplating solution from Dow Electronic Materials. A reduced ammonia concentration combined with additional ligands incorporated into this new plating solution facilitates a stable electrolyte and an easy to operate process. Despite the low ammonia content, PALLAMET 600 Palladium-Nickel retains all the advantages of conventional ammonia-based palladium-nickel plating solutions.

The bright palladium-nickel deposits of approximately 80% Pd/20% Ni produced from the PALLAMET 600 Palladium-Nickel electroplating solution exhibit low internal stress, excellent ductility and good adhesion to nickel and nickel alloy undercoats. Low porosity and excellent corrosion and wear resistance make the deposits suitable for various electronic applications, when used with a thin flash gold topcoat. PALLAMET 600 Palladium-Nickel electroplating solution can be operated at higher temperature and offers consistent performance over a wide range of current density. This electroplating solution can be used for barrel applications and for reel-to-reel applications with a variety of selective plating cell designs (e.g., controlled depth, brush plating, jet plating, spot plating).

Advantages
• Elimination of ammonia odour.
• Chloride-free, near neutral pH bath avoids corrosion of equipment/anode/substrate.
• Stable alloy composition over wide range of current density and plating conditions.
• Analytical procedures available for all bath components.
• Long bath life and stable bath performance.
• Excellent deposit ductility.
• Excellent corrosion resistance, wear resistance and solderability.
• Low, stable contact resistance
**Bath Make-up**

**High Speed Applications**

<table>
<thead>
<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>PALLAMET™ 600 Make-up</td>
<td>500 mL</td>
</tr>
<tr>
<td>PALLADURE™/PALLAMET Palladium Salt</td>
<td>50 g</td>
</tr>
<tr>
<td>PALLAMET 500 Nickel Concentrate (100 g/L Ni)</td>
<td>80 mL</td>
</tr>
<tr>
<td>PALLAMET 600 Additive</td>
<td>5 mL</td>
</tr>
<tr>
<td>PALLAMET 600 Wetting Agent</td>
<td>2 mL</td>
</tr>
<tr>
<td>D.I. water</td>
<td>To make one litre</td>
</tr>
</tbody>
</table>

**Barrel Applications**

<table>
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<tr>
<th>Chemicals Required</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>PALLAMET 600 Make-up</td>
<td>500 mL</td>
</tr>
<tr>
<td>PALLADURE/PALLAMET Palladium Salt</td>
<td>10 g</td>
</tr>
<tr>
<td>PALLAMET 500 Nickel Concentrate (100 g/L Ni)</td>
<td>16 mL</td>
</tr>
<tr>
<td>PALLAMET 600 Additive</td>
<td>5 mL</td>
</tr>
<tr>
<td>PALLAMET 600 Wetting Agent</td>
<td>2 mL</td>
</tr>
<tr>
<td>D.I. water</td>
<td>To make one litre</td>
</tr>
</tbody>
</table>

**Make-Up Procedure**

1) Add 300 mL distilled or D.I. water to a clean tank.
2) Add PALLAMET™ 600 Make-up and mix thoroughly.
3) Add PALLADURE™/PALLAMET Palladium Salt and mix thoroughly.
4) Add PALLAMET 500 Nickel Concentrate (100 g/L Ni) and mix thoroughly.
5) Add PALLAMET 600 Additive and mix thoroughly.
6) Add PALLAMET 600 Wetting Agent and mix thoroughly.
7) Dilute to final volume with distilled or D.I. water.
8) Check and adjust pH to 7.0 at room temperature using sulphuric acid solution (50% v/v) reagent grade. The plating solution should be clear and blue-green in colour.

**Recommended Process Cycle**

1) Alkaline electroclean.
2) Acid activation.
3) Nickel plating: NIKAL™ MP-200 (SE), SC Sulphamate or PC Sulphamate Electrolytic Nickels.
4) Nickel activation: Acidic Activation or Strike (See Note 4).
5) PALLAMET™ 600 Palladium-Nickel.
7) Dry.
### Operation Parameter

#### High Speed Applications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum 80% Pd/20% Ni Alloy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palladium</td>
<td>15–35 g/L</td>
<td>20 g/L</td>
</tr>
<tr>
<td>Nickel</td>
<td>6–15 g/L</td>
<td>8 g/L</td>
</tr>
<tr>
<td>Palladium to Nickel ratio (weight)</td>
<td>2.0–3.0:1.0</td>
<td>2.5:1.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>50–70°C</td>
<td>60°C</td>
</tr>
<tr>
<td>pH</td>
<td>6.8–7.5</td>
<td>7.0 (at RT)</td>
</tr>
<tr>
<td>Current density</td>
<td>5–60 A/dm²</td>
<td></td>
</tr>
<tr>
<td>Agitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>0.05 microns per second at 10 A/dm²</td>
<td></td>
</tr>
</tbody>
</table>

#### Barrel Applications

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<tr>
<th>Parameter</th>
<th>Range</th>
<th>Optimum 80% Pd/20% Ni Alloy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palladium</td>
<td>3.5 – 4.5 g/L</td>
<td>4 g/L</td>
</tr>
<tr>
<td>Nickel</td>
<td>1.6 – 2.0 g/L</td>
<td>1.8 g/L</td>
</tr>
<tr>
<td>Palladium to Nickel ratio (weight)</td>
<td>2.0–3.0:1.0</td>
<td>2.2:1.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>50–70°C</td>
<td>60°C</td>
</tr>
<tr>
<td>pH</td>
<td>6.8–7.5</td>
<td>7.0 (at RT)</td>
</tr>
<tr>
<td>Current density</td>
<td>0.3 – 1.0 A/dm²</td>
<td></td>
</tr>
<tr>
<td>Agitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deposition rate</td>
<td>0.3 microns per minute at 1 A/dm²</td>
<td>0.026 g of alloy per Ampere-minute</td>
</tr>
</tbody>
</table>

### Deposit Data

- **Alloy:** 70–90% palladium, 30–10% nickel
- **Density:** approximately 11 g/cm³
- **Hardness:** 350–450 Knoop Hardness
- **Ductility:** >8% (tested according to ASTM 489)
- **Tensile Stress:** 200–400 MPa (29–58 KPSI)
**Solution Maintenance**

**PALLADURE™/PALLAMET™ Palladium Salt**

PALLADURE/PALLAMET Palladium Salt contains 39% palladium metal. Palladium concentration is maintained by analysis or based upon an ampere-minute replenishment schedule that is regularly confirmed by solution analysis. To raise the palladium concentration by 1.0 g/L, add 2.56 g/l of PALLADURE/PALLAMET Palladium Salt.

PALLADURE/PALLAMET Palladium Salt should be pre-dissolved in a small quantity of D.I. water at approximately 50°C, or in a small quantity of the working electrolyte, to avoid unnecessary bath volume growth. After adding the PALLADURE/PALLAMET Palladium Salt the solution must be mixed thoroughly before checking and adjusting the pH as required.

**PALLAMET Special Palladium Salt**

PALLAMET Special Palladium Salt does not contain sulphate. Using PALLAMET Special Palladium Salt to replenish palladium metal does not increase S.G. of the plating solution and the bath life is therefore significantly extended. The addition of PALLAMET Special Palladium Salt increases the bath pH, resulting in a reduction of the amount of NaOH solution needed for pH adjustment.

PALLAMET Special Palladium Salt contains 36% palladium metal. To raise the palladium concentration by 1.0 g/L, add 2.78 g/L of PALLAMET Special Palladium Salt. Since PALLAMET Special Palladium Salt dissolves quickly in the plating solution (pH < 8.0) at the operating temperature, it can be added directly without pre-dissolution. After adding PALLAMET Special Palladium Salt the solution must be mixed thoroughly, before pH measurement and adjustment.

**CAUTION:** Only PALLADURE/PALLAMET Palladium Salt or PALLAMET Special Palladium Salt should be used.

**PALLAMET 500 Nickel Concentrate (100 g/L Ni)**

To raise nickel metal concentration by 1.0 g/L, add 10.0 ml/l PALLAMET 500 Nickel Concentrate. Note that the sulphate content in the plating solution increases with the addition of PALLAMET 500 Nickel Concentrate.

**PALLAMET 600 Additive**

PALLAMET 600 Additive is required to extend the higher current density plating range and to ensure good adhesion of the palladium-nickel deposit over nickel undercoats. The recommended concentration of PALLAMET 600 Additive is 2–10 mL/L. For every 100 g of alloy deposited (approximately 3,800 Amin), add 50 mL of PALLAMET 600 Additive, or add PALLAMET 600 Additive according to analysis.

**PALLAMET 600 Replenisher**

PALLAMET 600 Replenisher contains an additional complexing agent required during operation to maintain the solution stability and bath performance. For every 100 g of alloy deposited (approximately 3,800 Amin), add 300 mL of PALLAMET 600 Replenisher. In barrel applications, the consumption rate may be higher due to higher drag-out. For further information, please refer to Note 3.

**pH Control**

pH of the plating solution should be measured at room temperature or using pH meters with temperature correction. RONAMET™ UMT Alkali Concentrate (400 g/L NaOH) or sulfuric acid solution (50% v/v) reagent grade are used to raise or lower the solution pH. Do not use NaOH in solid form for pH adjustment.
PALLAMET™ 600 Wetting Agent
PALLAMET 600 Wetting Agent is required to lower the surface tension of the plating solution and to prevent defects in the deposit, such as pores and pitting. It is recommended to initially add 2 mL/L PALLAMET 600 Wetting Agent. To further decrease the surface tension of the plating solution, do not make additions of more than 2 mL/L at one time. The optimum surface tension of the plating solution is between 50–55 mN/m. For brush plating, a lower surface tension (≤50 mN/m) is beneficial. PALLAMET 600 Wetting Agent is mainly consumed by solution drag-out.

PALLAMET 600 Brightener
PALLAMET 600 Brightener is used as required to increase the brightness of the deposit and the contamination tolerance of the plating solution. Addition of PALLAMET 600 Brightener does not influence the adhesion or the ductility of the deposit. Add PALLAMET 600 Brightener in 2 mL/L increments as necessary (up to 10 mL/L). The use of PALLAMET 600 Brightener is controlled by Hull Cell appearance.

PALLADURE™ Anode Depolarizer
PALLADURE Anode Depolarizer is used as required to minimize anode filming or yellow precipitation due to the anodic oxidation of bath components. Add up to 10 mL/L PALLADURE Anode Depolarizer in 2 mL/L increments as necessary.

Notes
1) PALLAMET™ 600 Palladium-Nickel is designed to operate at lower ammonia content. The vapour loss of ammonia during the operation is therefore minimised. The minimum ammonia content (approximately 30–50 g/L) required for optimum bath performance is normally maintained by the metal replenishment. No addition of ammonia/ammonium hydroxide is needed during normal operation. The ammonia content in the plating solution can be checked by a simple acid/base titration as described in analytical method for ammonia.

If a PALLAMET 600 Bath is left idle for a long time (1 week or more), the free ammonia content should be checked and adjusted to the optimum value by adding ammonium hydroxide solution before operation.

2) In general, low pH of the plating solution (6.8 to 7.0) helps to eliminate ammonia loss during operation and maintain stable pH. Higher operating pH (>7.0) may be necessary for aged baths, with high sulphate content, in order to prevent salt-out at room temperature.

3) The consumption rate of the complexing agent contained in PALLAMET 600 Replenisher may vary with production conditions, especially the type of activation/strike and palladium-nickel bath drag-out rate. Once the replenishing program has been established, no regular control of the complexing agent in the bath is necessary. It is possible to analyse the complexing agent by FTIR if necessary. The recommended concentration of complexing agent is 60–100 g/L. To raise the concentration of the complexing agent by 2.0 g/L, add 10 ml/l PALLAMET 600 Replenisher.

For special plating conditions, two separate replenishing components, PALLAMET 600 Replenisher Part A and PALLAMET 600 Replenisher Part B, are available. Use these two special replenishers under the instruction of local Dow Electronic Materials representatives.
4) To facilitate excellent adhesion of Pd-Ni over different types of nickel surface, an acidic activation or acidic strike prior to Pd-Ni plating is recommended. The PALLAMET™ Acidic Strike is a special nickel strike product designed for use prior to PALLAMET 600 Palladium-Nickel. Drag-in of the PALLAMET Acidic Strike electrolyte does not have any detrimental effect on the PALLAMET 600 Palladium-Nickel plating bath, therefore no rinsing step is necessary between PALLAMET Acidic Strike and PALLAMET 600 Palladium-Nickel.

5) It is recommended to record the specific gravity of the plating solution regularly during production. The specific gravity value of a new make-up is approximately 1.12. The specific gravity normally increases with bath age and slowly becomes stable depending on the palladium salt used and the drag-out rate of the line. The maximum specific gravity of the plating solution should not exceed 1.35.

**Equipment**

Tank: Koroseal-lined, PVDC, polypropylene or other suitable plastics.

Anodes: Platinised Titanium or Mixed Oxide Titanium as offered by Dow.

Heaters: Immersion quartz, stainless steel or PTFE heaters.

Filtration: 1 micron filters with a pump capacity for a minimum of four solution turnovers per hour.

Fume exhaust: Recommended.

**Associated Products**

PALLAMET™ 600 Make-up
PALLADURE™/PALLAMET Palladium Salt
PALLAMET Special Palladium Salt
PALLAMET 500 Nickel Concentrate (100 g/L Ni)
PALLAMET 600 Additive
PALLAMET 600 Replenisher
PALLAMET 600 Brightener
PALLAMET 600 Wetting Agent
PALLADURE Anode Depolarizer
RONAMET™ UMT Alkali Concentrate
Handling Precautions

Before using this product, associated generic chemicals, or the analytical reagents required for its control consult the supplier’s Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product 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 appropriate 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.

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