Trends in Plating on Plastics
Double-Shot Molded Parts and Plating of Engineered Resins
Current Market Activity

- **Double-Shot Molds**
  - Reduce / eliminate assembly costs
  - Intricate design

- **New Plastics – replace metal**
  - Light Weight

- **Electronics MID**
  - Weight Reduction
  - Connectors
Examples

1. Medical Devices
2. Consumer Electronics/Lighting
3. Door Handles
4. Key Fobs
5. Grills
6. Vent Plates
7. Cockpit designs
   - Instrument clusters
   - Radio/climate control panels
   - Trim
Double (Twin)-Shot

- Double (Twin)-shot molding involves making parts with both a plateable and non-plateable plastic resin.

- Expertise with etching and activation enables controlled and highly selective plating without yield loss.

<table>
<thead>
<tr>
<th>shot 1</th>
<th>shot 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC/ABS (plateable)</td>
<td>PC (non-plateable)</td>
</tr>
</tbody>
</table>
Double (Twin)-Shot

- Molded Device is made from double-shot molding, different plastics in each shot
- Etch solution only etches one of them
Double (Twin)-Shot

1. Lower assembly cost
   - Two integrated resins to make one piece
   - No post plating assembly

2. More intricate designs
   - In mold designs
   - Colored textured plastic + chrome
   - 3D designs possible
Weight Reduction

• Need good slide for light weight metal replacement door handle
MID Metallization Technologies

- Embedded catalysts
  - Palladium
  - LDS (LPKF)

- Etch-defined
  - Double-shot molded part, no embedded catalyst
  - Plated shot etches, non-plated shot does not (ABS plated vs. PC non-plated, chromic etch)

- Printed image
  - ABS printing, process like etch-defined 2-shot
  - Catalyst printing (Microcat)

- Methods drivers are cost and cycle time
MID Applications

• Cell phones
  – Antennas, mostly
  – China, Taiwan, and Korea

• Electronic connectors
  – US and Asia

• Medical Devices
  – Mass production devices, such as Insulin delivery devices
  – US and Asia

• Automotive components
  – Relatively low production, varied parts

• LED lighting components
  – MID technology use increasing
MID Processes

2-shot molded, plated shot Pd-doped, exposed by etching

Laser-Direct-Structuring (LPKF): Single-shot mold, plated areas defined and catalyzed by laser
Question: What do all these unique applications have in common?
Answer: They all have special requirements to prepare the surface for metal deposition. From etching of the surface to initiating the catalyst to allow for electroless metal deposits…
Preparing Surface for Metallization

- Sand/bead blasting
  - Expensive
  - Inconsistent
  - Uniformity of etch recesses is problematic

- Chemical Etch
  - Hazardous
  - Not for all plastics

- Plasma (Flame)
  - Process control issues
  - Time limits
Preparing Surface for Metallization

- Sulfonation
  - Existing technology
  - Consistency concerns

- Controlled, vapor-phase, technology developed
  - Surface Activation™
Preplate Options

- Three types of POP pre-plate treatment processes are in commercial use today
  - Conventional Colloidal (Macuplex)
  - Direct Metallization/Short Cycle
  - Ionic Pd° (Macuplex Infinity)

- Similar electrolytic plating systems are common to all
### POP Pretreatment Layout

#### Conventional
- Cr Etch
- Cr Neutralize
- Pre Dip
- Pd Activate
- Accelerate
- EN/Ecu
- Electroplate

#### Direct/Short Cycle
- Cr Etch
- Cr Neutralize
- Pre Dip
- Pd Activate
- Cu-Sn Exchange
- N/A
- Electroplate

#### Ionic
- Cr Etch
- N/A
- Pd Activate
- Accelerate
- N/A
- EN/Ecu
- Electroplate
Selective Plating Cycle

- It is MacDermid’s opinion that independent of the method used for surface preparation that most logical path for plating of two-shot moldings and engineered plastics, is a ionic palladium system.
- With a correct set-up, several of these new processes can be run in the same tanks.
- **Example** (rinses omitted)
  - Chromic acid etch or LCP Etch or Laser or SAT
  - Macuplex Infinity Activator
  - Macuplex Infinity Accelerator
  - Macuplex Electroless Copper or Nickel
Science of Activator...Colloidal

- Colloidal Pd is a mixture of Pd particles and a stabilizing sheath of SnCl$_2$
- This structure is a semi stable colloid that has a strong electro-negative (-) charge
- Its charge potential is opposite to that of ABS (+)
- This attracts Pd to the etched and wetted surface
Theoretical Structures

<table>
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<tr>
<th>Structure</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>Red blood cell</td>
<td>10 microns</td>
</tr>
<tr>
<td>Pd Colloid</td>
<td>2 nanometers</td>
</tr>
<tr>
<td>Ionic Pd</td>
<td>73 picometers</td>
</tr>
</tbody>
</table>

2 Nanometers = 500 colloids per micron
Macuplex Infinity

- Ionic Palladium is essentially a Pd solution, not suspension
- Ionic Pd radius (2+ ion) is 73 picometers
- Ionic Pd is 2,000x smaller than colloidal Pd
- Only has affinity for etched surfaces
- Highly stable, low concentration solution
- Ionic Pd not contaminated by drag in of Cr, Ni, or Cu
- Ionic Pd has many times more active sites per unit area
- More effective surface penetration and electroless activation

\[
Pd \text{ Colloid} \quad 2 \text{ nanometers} \quad \downarrow \quad \text{Ionic Pd} \quad 73 \text{ picometers}
\]
Benefits Ionic Palladium Activation

- Reduced pre-plate process steps
- Eliminates over-plate
- Lower palladium working concentrations
- Not prone to drip or pin skips
  - Hexavalent chromium is not a contaminant
- Increased adhesion values
- Can run double-shot selective etch, double-shot selective catalyzation, laser structured, catalytic ink, and conventional POP
- Most cost effective system for multiple projects
Plastics Successfully Processed

- ABS & PC/ABS
- PET Polyethylene terephthalate
- PBT Polybutylene terephthalate
- LCP Liquid-crystal polymers
- PEEK Polyether ether ketone
- PEI Polyetherimide
- Nylon 6 & 12
- TPO Thermoplastic PolyOlefin
- PP Polypropylene
- Phenolics
- Kevlar
Plating On Plastics demand continues to grow in global markets driven mainly by automotive sector consumption

- Conventional Colloidal systems remain the most trusted and versatile systems in global markets

- Direct Metallization remains niche even 20 years after introduction

- Ionic Systems offer flexibility and genuine cost reduction potential for the future
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