METALLIZATION OF PLASTICS

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PRESENTATION TOPICS

- Introduction to Cybershield
- Metallization Processes, Materials and Design Guidelines
  - Plating on Plastic
  - Conductive Paint Application
  - Dispensed Conductive Gasket
- Shielding Effectiveness of Coating Systems
- RoHS & WEEE Review
- Plastic Metallization Applications
- Summary and Q&A
CYBERSHIELD OPERATION

- Based in Lufkin, TX
- Business Focus Since 1987
  - EMI Shielding Systems
    - Electroless & Electrolytic Plating
    - Conductive Paint on Plastics
    - Dispensed Conductive Gasket
  - Turnkey Manufacturing Services
    - Injection Molding
    - Decorative Finishing
    - Mechanical Assembly
    - Hardware Installation
    - Part Marking
    - Ultrasonic Welding
- Electronic Component & Equipment Manufacturers

Registered ISO 9001:2008
## SERVED MARKETS

<table>
<thead>
<tr>
<th>Connectors</th>
<th>Wireless Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telecom Infrastructure</td>
<td>Networking Equipment</td>
</tr>
<tr>
<td>Servers/Routers</td>
<td>Storage Devices</td>
</tr>
<tr>
<td>Medical Electronics</td>
<td>Barcode/RFID Equipment</td>
</tr>
<tr>
<td>Military/Aerospace</td>
<td>Antenna</td>
</tr>
<tr>
<td>Industrial Equipment</td>
<td>ATM Equipment</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>Test Equipment</td>
</tr>
<tr>
<td>Automotive Electronics</td>
<td>Mobile Handsets</td>
</tr>
<tr>
<td>Audio Electronics</td>
<td>GPS Systems</td>
</tr>
</tbody>
</table>
PLASTIC METALLIZATION APPLICATIONS

- ESD Coatings
- EMI/RFI Shielding
- RF & Microwave Housings
- Antenna
- IR Heat Barrier
- Vapor Barrier
- Decorative Finishes
- Mil Spec Finishes, Including CARC
METALS DEPOSITED

- **Plating**
  - All-Over & Selective Electroless Plating – Copper, Nickel, Tin, Gold
  - All-over Electrolytic Plating – Copper, Nickel, Tin, Chrome
- **Conductive Paint**
  - EMI Shielding – Copper and Silver
  - ESD – Nickel and Graphite
# PLATEABLE RESINS

## Widely Plateable

<table>
<thead>
<tr>
<th>Material</th>
<th>Composition</th>
<th>Fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Polycarbonate (PC)</td>
<td>PC/ABS</td>
</tr>
<tr>
<td>PPA</td>
<td>Fiberglass</td>
<td>Polystyrene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liquid Crystal Polymer</td>
</tr>
<tr>
<td>PC/ABS</td>
<td></td>
<td>PEI (Ultem) ≥20% Fill</td>
</tr>
</tbody>
</table>

## Selected or Custom Blended Plateable Grades*

<table>
<thead>
<tr>
<th>Material</th>
<th>Brand</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noryl</td>
<td>Xylex</td>
<td>Urethane</td>
</tr>
<tr>
<td>Nylons</td>
<td>PEEK</td>
<td>Polypropylene</td>
</tr>
<tr>
<td></td>
<td>PPS</td>
<td></td>
</tr>
</tbody>
</table>

## Not Plateable

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Valox (PBT)</td>
<td>Polyethylene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polyester</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PVC</td>
<td></td>
</tr>
</tbody>
</table>

* Only Selected or Custom Blended Resins Can Be Plated.
PLATING ON PLASTICS

**All-Over Electroless**
- Acid/Caustic Etch or Abrade
- Activate with Catalyst
- Plate 1-10 µm (40-400 µ”) Copper, Nickel, Tin, Gold

**Selective Plating**
- Mask Part
- Apply Auto-Catalytic Primer
- Plate 1-5 µm (40-200 µ”) Copper, Nickel, Tin, Gold

**Electrolytic Plating**
- All-Over Electroless Plate
- Rack & Contact
- Plate 5-75 µm (200 µ”–.003”) Copper, Nickel, Chrome
ELECTROLYTIC PLATING

- Start with Electroless Copper Plated Plastic Part
- Offers Outstanding EMI Shielding, Includes Magnetic Interference
- Plating Material Options: Copper, Nickel, Tin, Chrome
- Thicker Coatings with Excellent Long Term Performance
- Faster Deposition & Lower Cost Than Electroless Plating
- Line-of-Sight Process with Wider Thickness Variation
SELECTIVE PLATING

- Mask Selected Areas of Part & Apply Catalytic Plating Primer
- Apply Electroless Copper Plating and Finish with Electroless Ni, Sn, Au
- Mask Line Tolerance +/-0.020” (0.5 mm)
- Maintain Unplated Part Molded Color & Texture

Auto Darkening Welding Helmet Covers
2-SHOT MOLDING

- Utilize All-Over Plating Process on 2-Shot Molded Parts
  - Plateable Resin - Catalyzed to Promote Plating
  - Non-Plateable Resin
  - Feature Size to <0.20” (0.5 mm)

- Mold Tool Designed for 2-shot Molding Process

- Resins Must Have Compatible Molding Parameters
PLATING RESIST

- Similar to PC Board Resist Materials & Processes – Utilize All-Over Plating Process
- Resist Compatible with Electroless Plating Chemistry
- Applied onto Required Areas via Dispensing or Spraying, Followed by UV Cure
- Resist Can Be Left on Part or “Peeled” off After Plating
- Finish with Electroless Nickel or Electroplate with Copper, Nickel, Tin, and/or Gold
# PLATING DESIGN ISSUES

<table>
<thead>
<tr>
<th>Design Don’t</th>
<th>Design Alternative</th>
</tr>
</thead>
</table>
| 5-sided Box or Cup Design Trap Air and/or Drag Out Plating Chemicals      | Include Drain Holes  
| Impact Plating Quality & Cost                                            | Design Part to Prevent Entrapment of Air or Plating Solution                          |
| Tight Crevices Can Trap Plating Solution                                   | Eliminate Crevices in Design or Include Drain Hole                                    |
| Small Blind Holes Trap Plating Solution                                    | Utilize Through-holes  
| Later Weep Out & Damage Plating                                            | If Blind Holes Required, Plug to Prevent Plating Solution Entrapment                  |
| **Inserts**                                                                |                                                                                     |
| ● Brass or Stainless Inserts - Ultrasonic or Heat Stake Before/After Plating |                                                                                     |
| ● Inserts Installed Before Plating - Mask Threads with Screws During Plating |                                                                                     |
CONDUCTIVE PAINT

- Air Atomization of Metallic Paints
- Coatings
  - Graphite, Ni, Cu, Ag, Hybrid Cu-Ag
  - Thickness: 0.5-2.0 mils (12-50 µm)
  - Electro-form Mask for Selective Application
- Thickness Uniformity & Repeatability via Robotic Application
- Widest Resin Capability
- “Flexible” Conductive Paint for Application onto Paper or Fabric
- Avoid Designs with Tight Crevices & Bosses, and Small Blind Holes
## PAINTABLE RESINS

### Common Paintable Resins

<table>
<thead>
<tr>
<th>Resin Type</th>
<th>Resin Name</th>
<th>Resin Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Polycarbonate (PC)</td>
<td>Polybutylene Terephthalate (PBT)</td>
</tr>
<tr>
<td>PC/ABS</td>
<td>Poly Aryl Amide</td>
<td>Polyphenylene Oxide (PPO)</td>
</tr>
<tr>
<td>PC/PBT</td>
<td>Polymethylene PPA</td>
<td>Polyether Imide (PEI)</td>
</tr>
<tr>
<td>Nylon</td>
<td>Polystyrene (PS)</td>
<td></td>
</tr>
</tbody>
</table>

### Difficult to Paint Resins (May Require Primer)

<table>
<thead>
<tr>
<th>Resin Type</th>
<th>Resin Name</th>
<th>Resin Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teflon (PTFE)</td>
<td>Polyethylene</td>
<td>Liquid Crystal Polymer</td>
</tr>
<tr>
<td>PEEK</td>
<td>Polyimide</td>
<td>Polypropylene</td>
</tr>
</tbody>
</table>
## CONDUCTIVE PAINT DESIGN

<table>
<thead>
<tr>
<th>Design Don’t</th>
<th>Design Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult to Paint Tight Bosses, Crevices and Holes Line-of-Sight Paint Process</td>
<td>Eliminate Crevices &amp; Small Holes Requiring Coating</td>
</tr>
</tbody>
</table>

**Inserts**
- Brass or Stainless Inserts - Ultrasonic or Heat Stake Before/After Painting
- Inserts Installed Before Painting - Mask Threads with Screws During Plating
## SHIELDING EFFECTIVENESS

<table>
<thead>
<tr>
<th>Coating System</th>
<th>Thickness</th>
<th>Resistivity</th>
<th>30 MHz</th>
<th>100 MHz</th>
<th>300 MHz</th>
<th>1 GHz</th>
<th>5 GHz</th>
<th>10 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-Over Plating</td>
<td>40-400 μ”</td>
<td>5-50</td>
<td>90</td>
<td>108</td>
<td>104</td>
<td>120</td>
<td>113</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>(1.0-10.0 μm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective Plating</td>
<td>80-200 μ”</td>
<td>15-100</td>
<td>77</td>
<td>73</td>
<td>71</td>
<td>71</td>
<td>60</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>(2.0-5.0 μm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Paint</td>
<td>0.001-.0015”</td>
<td>25-100</td>
<td>65</td>
<td>63</td>
<td>59</td>
<td>70</td>
<td>81</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>(0.025-.375 mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper-Silver Paint</td>
<td>0.0008-.001”</td>
<td>15-50</td>
<td>78</td>
<td>73</td>
<td>72</td>
<td>69</td>
<td>85</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>(0.020-.25 mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver Paint</td>
<td>0.0005-.001”</td>
<td>15-50</td>
<td>70</td>
<td>71</td>
<td>70</td>
<td>62</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>(0.0125-.025 mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Enthone, Spraylat and Cybershield
COATING QUALITY METRICS

- **Metal Deposition Thickness** – X-Ray Diffraction to Measure Individual Plating or Conductive Paint Layers
- **Resistivity** – Point-to-Point or Ohms/Square
  - Plating with 10 micro-inches (0.25 µm) Ni over 40-400 micro-inches (1.0 µm) Cu: 0.005-.100 Ohms/Square
  - Copper & Silver Conductive Paint 0.025-0.050 Ohms/Square @ 0.001” Dry Film Thickness
- **Adhesion** – ASTM D-3359
  - Destructive or Non-Destructive Test Method
  - Tape Test: Measure Plating Pulled on Visual Scale (1-5 with 5 Best – No Metal Pulled
- **UL QMRX2 Certification**
  - Certified Resins: [www.cybershieldinc.com/electroless.htm](http://www.cybershieldinc.com/electroless.htm)
CONDUCTIVE GASKET CAPABILITIES

- Silicone with Silver Plated Nickel, Copper or Aluminum Filler
- Dispense onto Metal, Painted or Plated Plastic via PC Controlled Robot
- Shielding Effectiveness: 85-120 dB
- Compression Set: <20% @ 50% Deflection
- Shore A Hardness: 48-70
- Gasket Size Range
  - Height: 0.015”-0.090” (0.38-2.3 mm)
  - Width: 0.018”-0.125” (0.46 -3.2 mm)
CARC PAINT APPLICATION

- Apply Mil Spec Paints
  - MIL-DTL-64159
  - MIL-PRF-22750
  - Apply Manually or on Robots

- Chemically Treat Metal
  - Zinc Phosphate Steel per TT-C-490
  - Conversion Coat Aluminum MIL-DTL-5541
RoHS/REACH & WEEE

- **RoHS: EU Directive - Restriction of Hazardous Substances**
  - Lead, Cadmium, Mercury, Hexavalent Chromium, Polybrominated Biphenyl (PBB), Polybrominated Diphenyl Ether (PBDE) Flame Retardants
  - All Cybershield Coatings RoHS Compliant

- **REACH (Registration, Evaluation, and Authorization of Chemicals)**
  - No Substances of Very High Concern (SVHC) in Any Coatings

- **WEEE - Waste from Electrical and Electronic Equipment**
  - Raise Level of Recycling of Electrical and Electronic Equipment
  - Manufacturers Responsible for Recycling Costs
  - Cybershield Processes to Remove Plating & Paint Coating to Allow for Plastic Recycling (Can Transfer Know-How)
INJECTION MOLDING

- Two 220T Cincinnati Milacron Presses
  - Capable of Wide Range of Resins
  - Part Size up to 8” x 10”
  - Up to 13 Ounce Shot
- Streamline Supply Chain
- Eliminate Freight Costs
APPLICATIONS
SHIELDED CONNECTORS

- Increasing Need for Shielded Interconnection
  - Medical
  - Military/Aerospace
  - Telecommunications
- Utilize All-Over Plating, 2-Shot
- Eliminate Weight, Space and Cost for Metal Shell
Conversion to Plastic to Reduce Weight
- EMI Shielding Achieved with Plating or Conductive Paint
- High Performance Plastics Meet Military Mechanical & Environmental Requirements
- Metallize Wide Range of Plastics

Manufacturing Services
- Gaskets
- Decorative Paint, Including Mil Spec CARC Paint
MOBILE ANTENNA

- Mobile Satellite Antenna Waveguide
- All-Over Plated
  - Copper 300 micro-inches (12.5 µm)
  - Nickel Flash
TELECOM SWITCH FACEPLATES

- All-Over Plated & Decoratively Painted Injection Molded Faceplates
  - Meet EMI Requirements
  - Color Match to Metal Chassis
- Mechanical Assembly
CONDUCTIVE GASKET

- Silicone Filled with Silver Plated Nickel, Copper or Aluminum
- Dispensed onto Metal Housing
  - Provide EMI Shield with 85-120 dB Attenuation
  - Mate with PC Board Traces
- High Volume Capability and Repeatable Precision Dispensing
ROUTER CHASSIS

- All Plastic Router Chassis
- All-Over Cu/Ni Plating
- Install 130 Inserts
- Assemble & Bond Chassis
- Decorative Paint
- EMI Shielding: 1-10 GHz
- Cost Effective Option to Sheet Metal Chassis
- Router: 65% Lighter Than Sheet Metal Design – Eliminated Cabling
GPS SURVEY EQUIPMENT

- Light Weight, Durable, Housing
- EMI Shielding
  - All-Over Electroless Plating on Polycarbonate Frame
  - Conductive Paint on Xenoy (PC/PET) Housing
- Inserts and Part Marking
SUMMARY

- Demonstrated Metallization Processes
  - Shielding, Thermal & Vapor Barriers, Antennas
  - Decorative Finishes on Wide Range of Resins
  - Cost Effective
  - High Volume Production Capacity
  - Reliable & Durable

- Design Flexibility
  - Materials Systems
  - Metallization Mechanical Design