Metallization of Plastics

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PRESENTATION TOPICS

- Introduction to Cybershield
- Metallization Processes, Materials and Design Guidelines
- Shielding Effectiveness of Coating Systems
- 3D Circuitry on Plastics
- Plastic Metallization Applications
- RoHS & WEEE Review
- Summary and Q&A

CYBERSHIELD OPERATION

- Based in Lufkin, TX
- Business Focus Since 1987
  - Metallization of Plastics
  - EMI Shielding Systems
  - Electro-Plating
  - Mechanical Assembly
- Serve Electronic Equipment Manufacturers

Registered ISO 9001:2000

CAPABILITIES

- Apply Functional & Decorative Coatings on Plastics
  - Electroless & Electrolytic Plating
  - Conductive Paint
- Value Added Services = Turnkey Solution
  - Decorative Paint
  - Dispensed Conductive and Non-Conductive Gaskets
  - Hardware Installation
  - Part Marking and Labeling
  - Ultrasonic Welding
  - Precision Hole Tapping
  - Mechanical Assembly
  - Supply Chain Management

SERVED MARKETS

Mobile Handsets	Wireless Devices
Telecom Infrastructure	Networking Equipment
Servers	Storage Devices
Medical Electronics	Barcode/RFID Equipment
Military/Aerospace	Routers
Industrial Equipment	ATM Equipment
Instrumentation	Test Equipment
Automotive Electronics	Connectors
Audio Electronics	GPS Systems

PLASTIC METALLIZATION APPLICATIONS

- ESD Coatings
- EMI/RFI Shielding
- RF & Microwave Housings
- Antenna
- IR Heat Barrier
- Vapor Barrier
- Decorative Finishes

METALLIZATION PROCESSES

- Plating on Plastics
  - All-Over and Selective
  - Electroless and Electro-Plating
  - Functional and/or Decorative
- Conductive Paints
  - Graphite, Nickel, Copper, Silver

PLATEABLE RESINS

Widely Plateable			
ABS*	Polycarbonate (PC)	PC/ABS*	PEI (Ultem) ≥20% Fill

Selected or Custom Blended Plateable Grades			
Noryl	Xylex	Xenoy	Epoxy
Polypropylene	PEEK	PPS	Liquid Crystal Polymer
Polystyrene	Urethane	Nylon	PPA

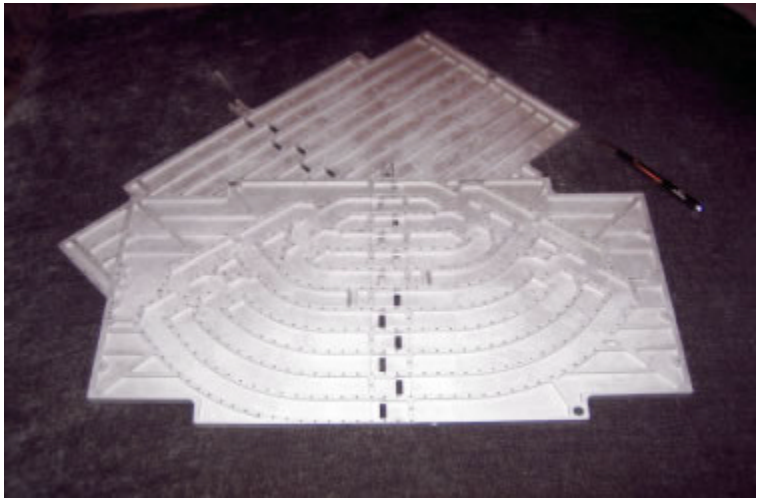
Not Plateable		
Valox (PBT)	Polyethylene	PVC

* Only Recommended Resins for Selective Plating

METALS DEPOSITED

- Plating
  - Electroless – Copper, Nickel, Tin, Gold
  - Electrolytic – Copper, Nickel, Bright Chrome
  - Conductive Paint
    - EMI Shielding – Nickel, Copper and Silver
    - ESD – Nickel and Graphite

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 Electroless	Mask Part	Apply Plating Catalyst & Cure	Plate 1-5 µm (40-200 µ") Copper, Nickel, Tin, Gold
Electro-Plating	All-Over Electroless Plate	Rack & Contact	Plate 2-75 µm (80 µ"–.003") Copper, Nickel, Chrome

ALL-OVER PLATING PROCESS

- Direct Plate onto Plastic Substrate
  - “Plateable Resin”
  - Glass or Mineral Filled Resin Enhance Plateability
  - Brominated FR Contaminate Plating Baths
- Prep Surface - Chemical Etch/Mechanical Abrade
- Apply Electroless Copper – No Electrical Contact
- Finish: Electroless/Electrolytic Cu, Ni, Sn, Au, Cr
- Adhesion Based on Resin ($\geq$ Circuits on PC Board)
- Uniform Coverage Over Entire Part
- Generally Lowest Unit Cost & NRE Option

ELECTROLESS PLATING FIXTURE

SELECTIVE PLATING PROCESS

- Mask Selected Areas of Part
- Spray & Cure Plating Catalyst
- Bypass Etch Process - Primed Areas Plate
- Apply Electroless Copper Plating and Finish with Electroless Ni, Sn, Au
- Maintain Unplated Part Molded Color & Texture
- Recommend for ABS & PC/ABS Only
- Adhesion Function of Primer to Plastic
  - Usually Less Than All-Over Plating
  - Limits Coating Thicknesses

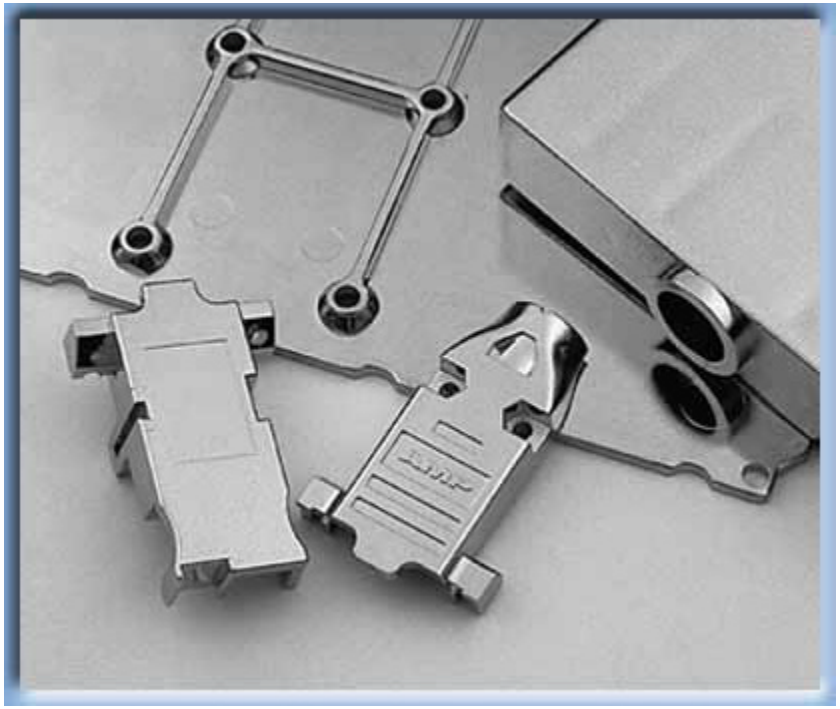
MASKING FIXTURES

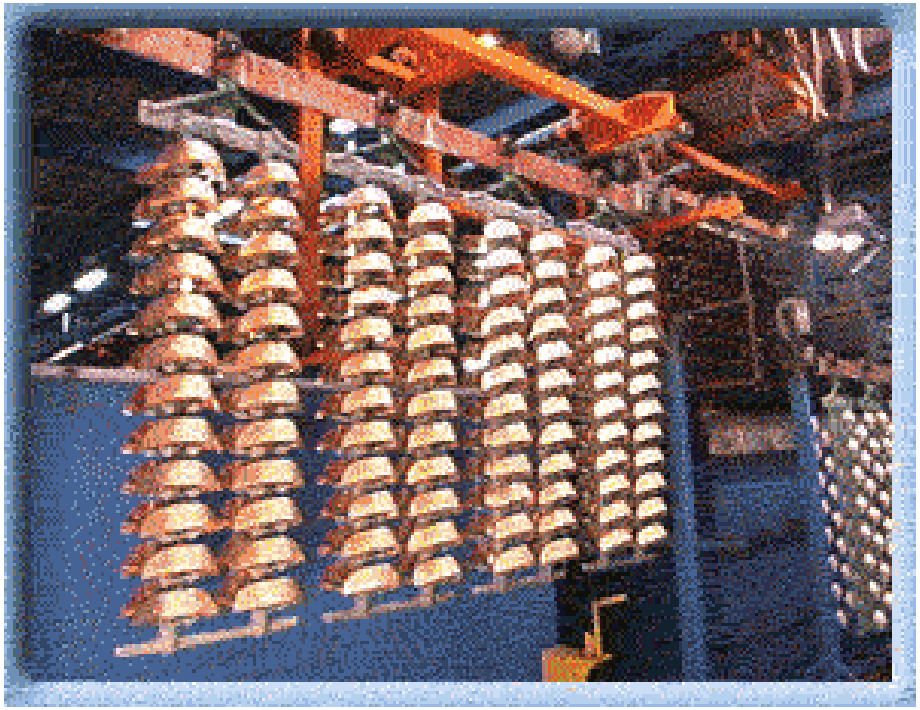
SELECTIVE PLATING FEATURES

- Uniform Coverage Over Entire Part
- Mask Line Tolerance +/-0.020-0.025” (0.5-0.6 mm)
- Moderate Unit Cost & NRE (2-step Process)
- Difficulty Plating Tight Bosses, Crevices, Holes
  - Spray Process to Apply Catalyst
- Avoid Blind Holes: Aspect Ratio > 5:1
  - Small Holes Trap Solution & Impact Plating Quality
  - Plug Holes - Adds Cost
- Avoid 5-sided Box Designs
  - Entraps Air and/or Drag out Chemicals
- Install Inserts Post Plating

ELECTRO-PLATING

- Electroless Plated Plastic Part
- Fast Deposition - Metal Thickness
- Decorative Chrome
- EMI Shielding



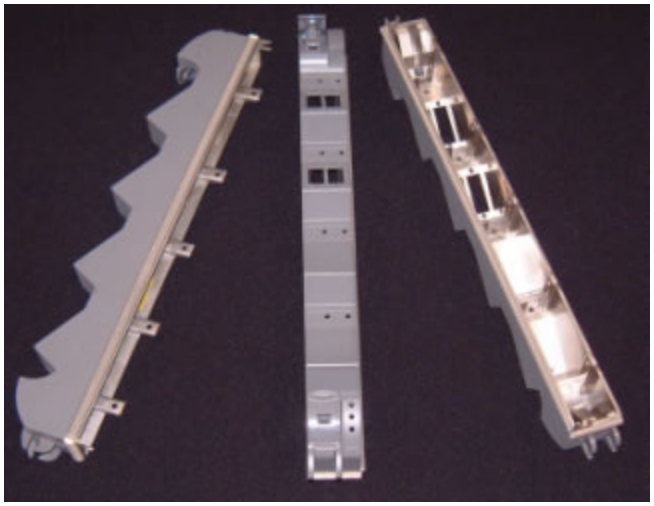


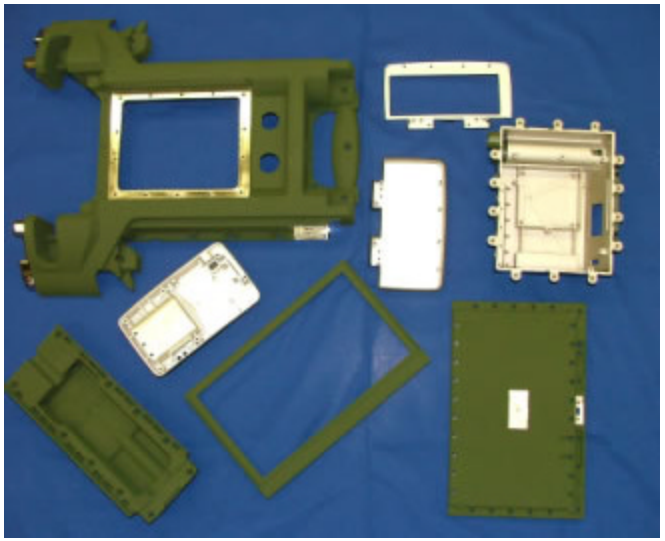
Line-of-Sight Process & Wider Thickness Variation

CONDUCTIVE PAINT

- Air Atomization of Metallic Paints
- Coatings
  - Graphite, Ni, Cu, Ag, Hybrid Cu-Ag
  - Thickness: 0.5-2.0 mils (12-50 mm)
  - Mask for Selective Application
  - High Paint Materials Costs
- Thickness Uniformity & Repeatability Via Robotic Application
- Widest Resin Capability
- Avoid Designs with Tight Bosses, Crevices, Small Blind Holes

DECORATIVE PAINT





- Decorative Paint Applied over Plating
  - Meet Cosmetic Requirements
  - Color Match Surrounding Components
  - Protect Plating from Abrasion
- Decorative Paint System Can Include Prime, Texture & Color
- Applied in Cybershield Paint Robots

DISPENSED CONDUCTIVE GASKET

- Silicone with Metal Particles for Conductivity
  - Silver Plated Ni, Al, or Cu
  - Dispensed via CNC
- Key Properties
  - Volume Resistivity: 0.005-0.008 ohms-cm
  - Shielding Effectiveness (200 MHz-10 GHz): 80-120 dB
  - Shore A Hardness: 40-60
  - Elongation: $\geq$100%
  - Compression Set: <20%
- EMI Seal for Housing Perimeter or Intra-Device Compartments

SHIELDING EFFECTIVENESS

		m-Ohms Per Square	dB Attenuation		
Coating	**Thickness**	**Resistivity**	**100 MHz**	**1GHz**	**10 GHz**
All-Over Plating	40-400 µ" (1.0-10.0 µm)	5-50	108	120	87
Selective Plating	80-200 µ" (2.0-5.0 µm)	25-100	83	71	62
Copper Paint	0.001-.0015" (0.025-.375 mm)	25-100	63	70	63
Copper-Silver Paint	0.0008-.001" (0.020-.25 mm)	15-50	65	69	70
Silver Paint	0.0005-.001" (0.0125-.025 mm)	15-50	73	62	55

Source: Enthone, Spraylat and Cybershield

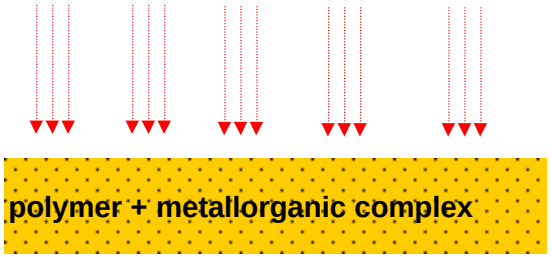
EXACT™ PRECISION 3D CIRCUITS

Additive Selective Metallization Process

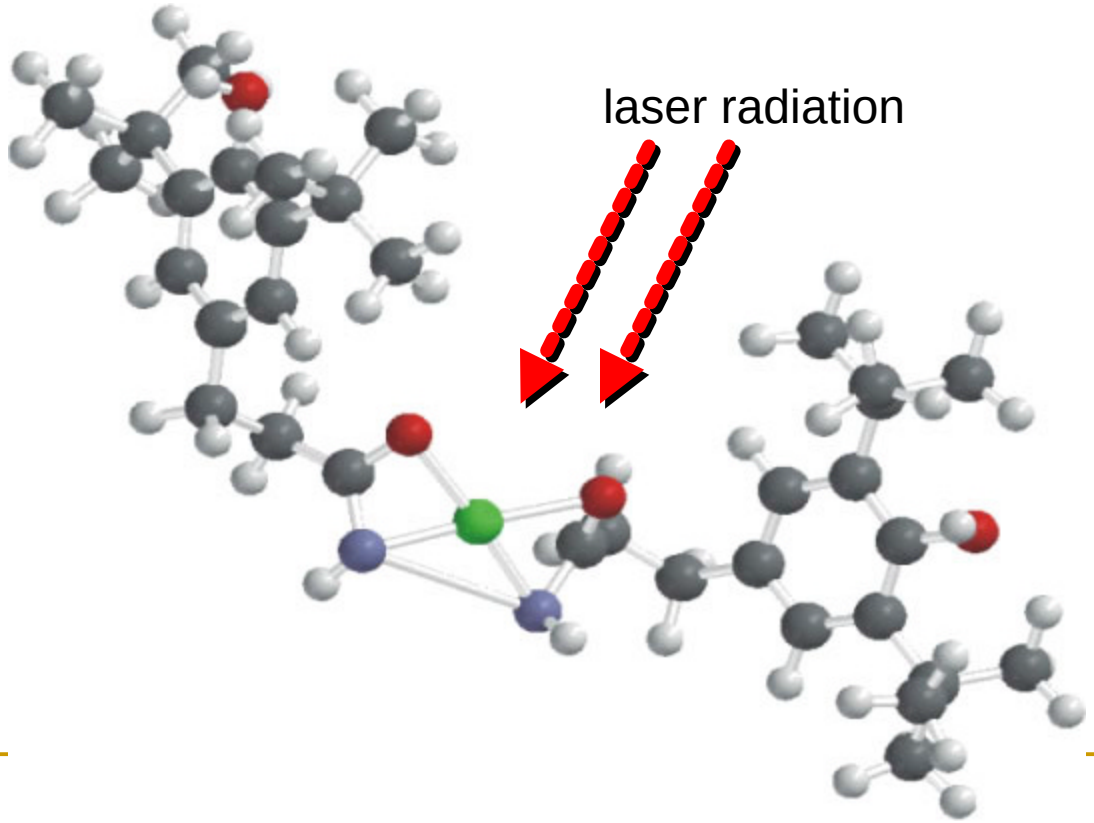
- Injection Mold
- Laser Activation
- Metallization
- Antenna & Circuits
- Attach Components
  - Solder
  - Conductive Epoxy

LASER ACTIVATION PROCESS

Metallorganic complex as a laser-activatable additive in the polymer matrix



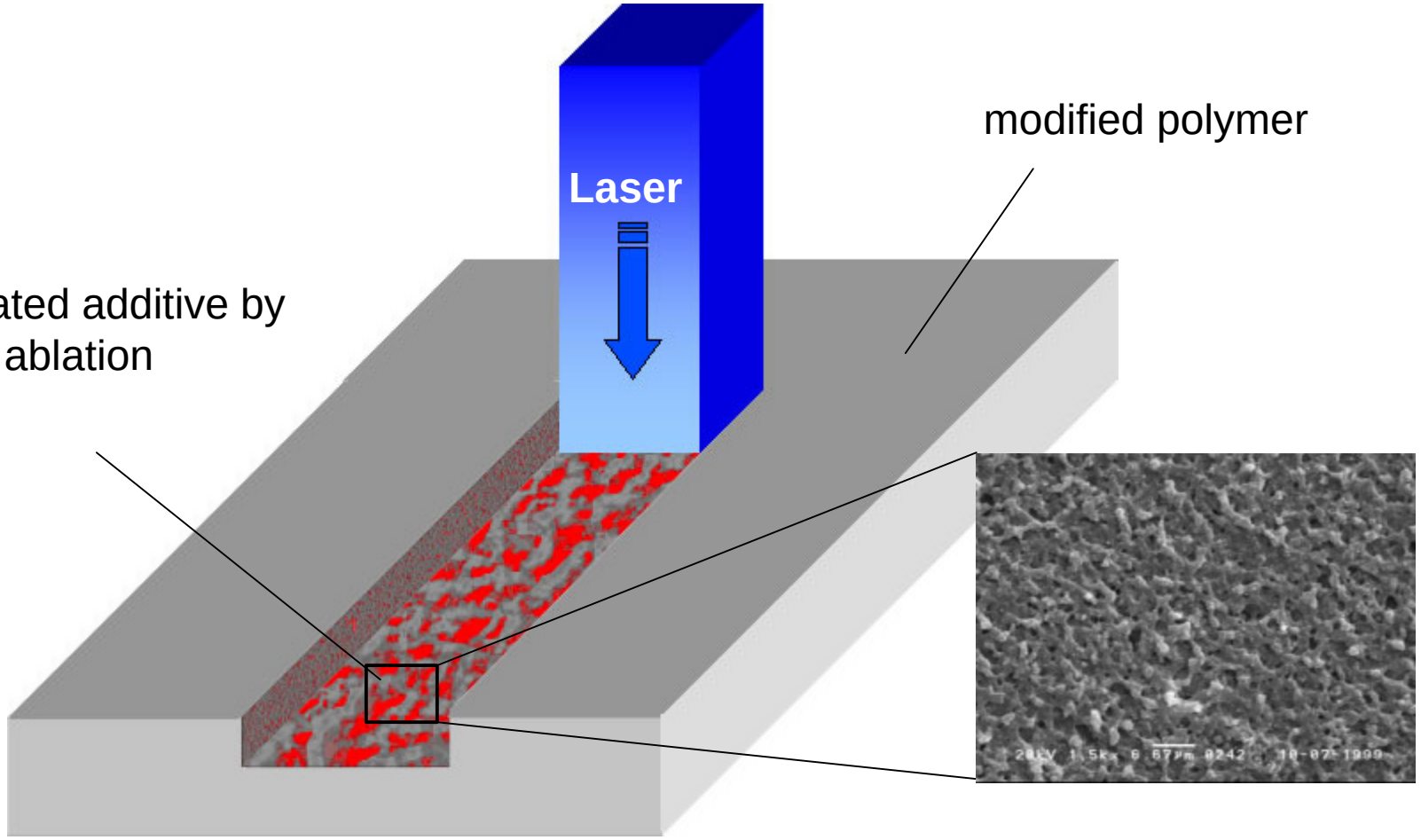
1. Selective activation of polymer



Metal
Nitrogen
Oxygen

SURFACE TREATMENT

Sketch:



LASER-ACTIVATION SYSTEM

DESIGN RULES

Part Size

- XY-size: up to 8” x 8” (200 mm x 200 mm)
- Z-extension: ≤2.0” (50 mm)

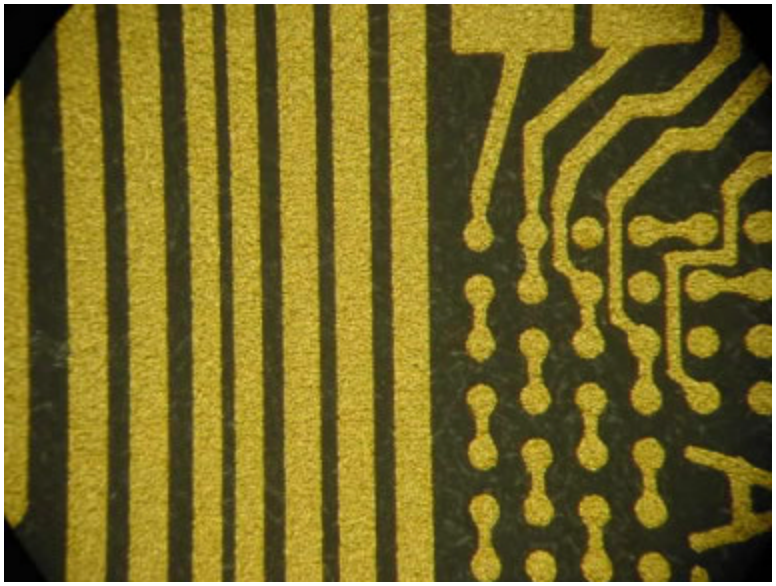
Circuitry

- Line Width: min. 0.004“ (0.1 mm)
- Space Width: min. 0.006“ (0.15 mm)
- Via Diameter: min. 0.008“ (0.2 mm)
- Aspect-ratio: 2:1
- Cone: min. 30°

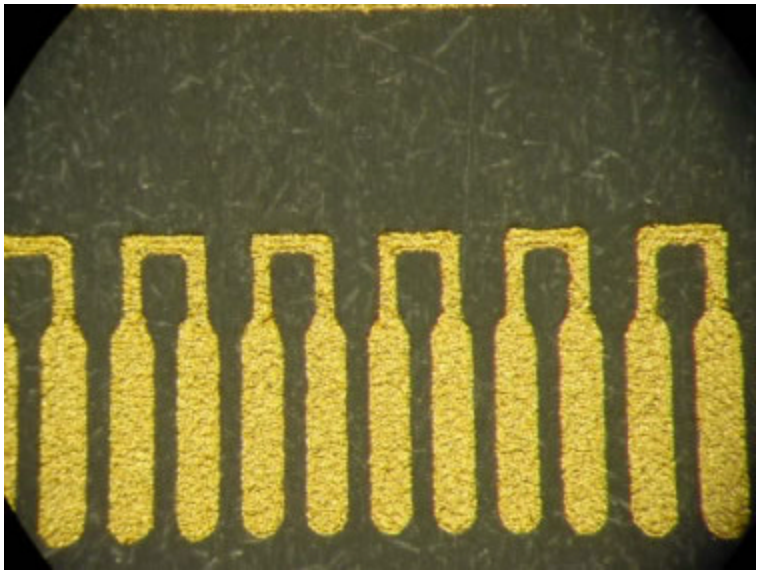
Available Plastic Resins

- Ticona Vectra E820i LCP
- BASF Ultramid PA6
- Lanxess PBT & PBT-PET Blend
- PC/ABS in Development – Expected in 2007

METALLIZATION



1 mm

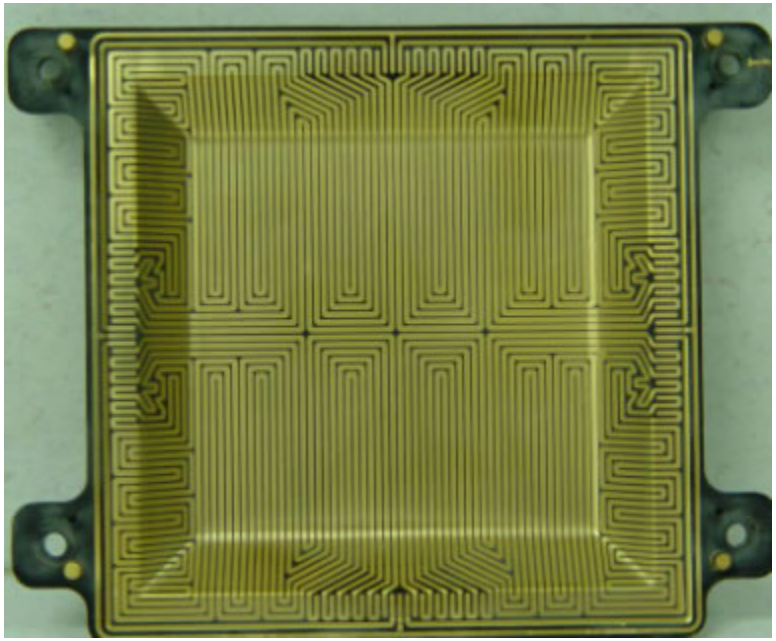


1 mm

Metallization: 8 µm Cu, 4 µm Ni, 0,1 µm Au

Solderable Circuits with LCP Resin

TAMPER RESISTANT COVER



- Visa/MasterCard Standard
  - Prevent ATM Tampering
  - Protect Customer Account
- Cybershield Solution
  - 3D Patterned PC/ABS Cover
  - 0.010” (0.25 mm) Spaces
  - Gold Plated Circuits to Mate with PC Board Contacts
  - Fail Safe if Continuity Broken

HEARING AID

- Solderable Plastic Resin
- Plate with Copper, Nickel, Gold
- Replaces PC Board and Frame

COATING QUALITY METRICS

- **Metal Deposition Thickness –** X-Ray Diffraction to Measure Individual Layers
- **Resistivity – Point-to-Point or Ohms/Square**
  - All-Over Plating with 10 micro-inches (0.25 µm) Ni over 40 micro-inches (1.0 µm) Cu: 0.01-.02 Ohms/Square
- **Adhesion – ASTM D-3359**
  - Destructive or Non-Destructive Test Method
  - Tape Test: Measure Plating Pulled versus Visual Scale (1-5 with 5 Best – No Metal Pulled)
- **UL QMRX2 Certification**
  - Thermal Cycling/Adhesion Testing/Bond Strength
  - Certified Resins: **www.cybershieldinc.com/electroless.htm**
  - New Resin Certification: 8 Weeks & $3K Fee to UL

RoHS & WEEE

- **RoHS: EU Directive - Restriction of Hazardous Substances**
  - Lead, Cadmium, Mercury, Hexavalent Chromium, Polybrominated Biphenyl (PBB), Polybrominated Diphenyl Ether (PBDE) Flame Retardants
  - Cybershield offers RoHS Compliant Coatings
- **WEEE - Waste from Electrical and Electronic Equipment**
  - Raise The 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)

APPLICATIONS

RIM BLACKBERRY

- Converted BlackBerry Shield from Magnesium to Plated Plastic
- All-Over Copper/Nickel Plate and Install 3 Inserts
- Working with RIM on New Plated Plastic Shield Applications for Future Models

MILITARY ELECTRONICS

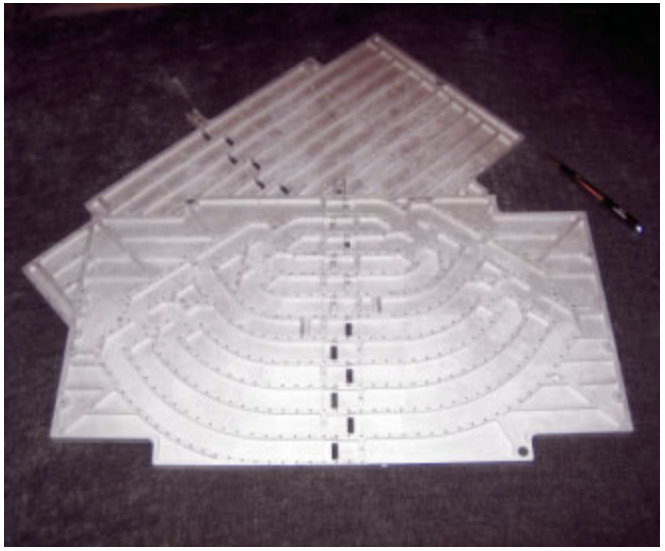
- Conversion to Plastic to Reduce Weight
  - EMI Shielding Achieved with Plating and Conductive Paint
  - High Performance Plastics Meet Military Mechanical & Environmental Requirements
  - Cybershield Expertise to Metallize Wide Range of Plastics
- Manufacturing Services
  - Gaskets
  - Decorative Paint
  - Assembly

ROUTER CHASSIS

Router Chassis

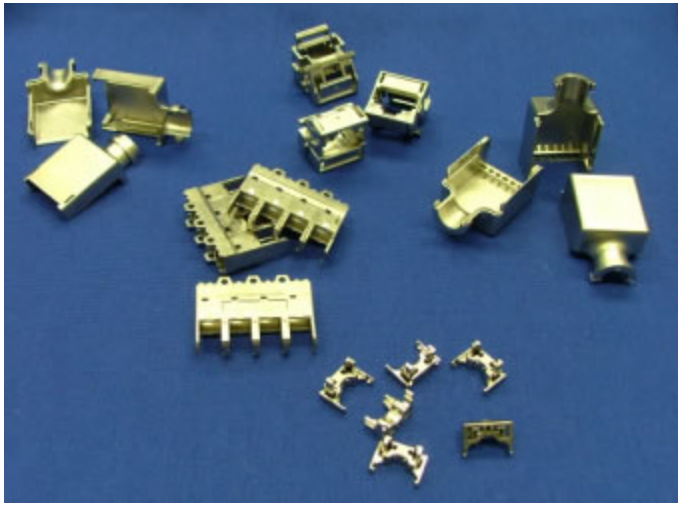
- All Plastic Router Chassis
- All-Over Cu/Ni Plating
- Install 130 Inserts
- Assemble & Bond Chassis
- Decorative Paint
- EMI Shielding: 1-10 GHz
- Cost Effective Option to Sheet Metal Chassis
- Router: 65% Lighter Than Sheet Metal Design – Eliminated Cabling

MOBILE ANTENNA



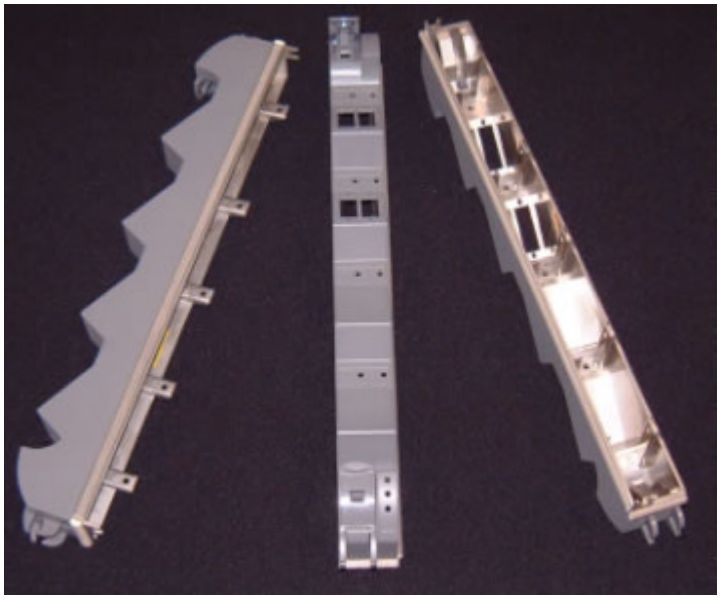
- Mobile Satellite Antenna Waveguide
- Plated with 300 µ” Cu & Ni flash
- Additional Waveguide Applications in Development

SHIELDED CONNECTORS



- Increasing Need for Shielded Interconnection
  - Medical
  - Military/Aerospace
  - Telecommunications
- Eliminate Weight, Space and Cost for Metal Shell
- Major Customers: Tyco, Panduit, Commscope

TELECOM SWITCH FACEPLATES



- Customers
  - Alcatel, Motorola, Nortel
  - Alcatel Moved Molding to US – Cybershield Prime Supplier
- Plated/Painted Injection Molded Faceplates
  - Meet EMI Requirements
  - Color Match to Metal Chassis
- Mechanical Assembly

GPS SURVEY EQUIPMENT

- Light Weight, Durable, Housing
- EMI Shielding
  - Electroless Plating
  - Conductive Paint
- Inserts and Part Marking

SUMMARY

- Demonstrated Metallization Processes
  - Shielding, Functional Circuits, Antennas
  - Decorative Finishes on Wide Range of Resins
  - Cost Effective
  - High Volume Production Capacity
  - Reliable & Durable
- Design Flexibility
  - Materials Systems
  - Metallization Mechanical Design