
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) $\geq 20\%$ Fill
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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
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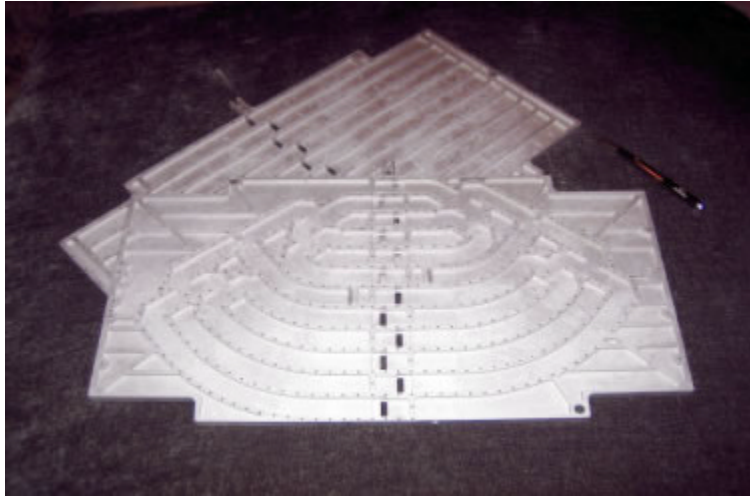
* Only Recommended Resins for Selective Plating

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
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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



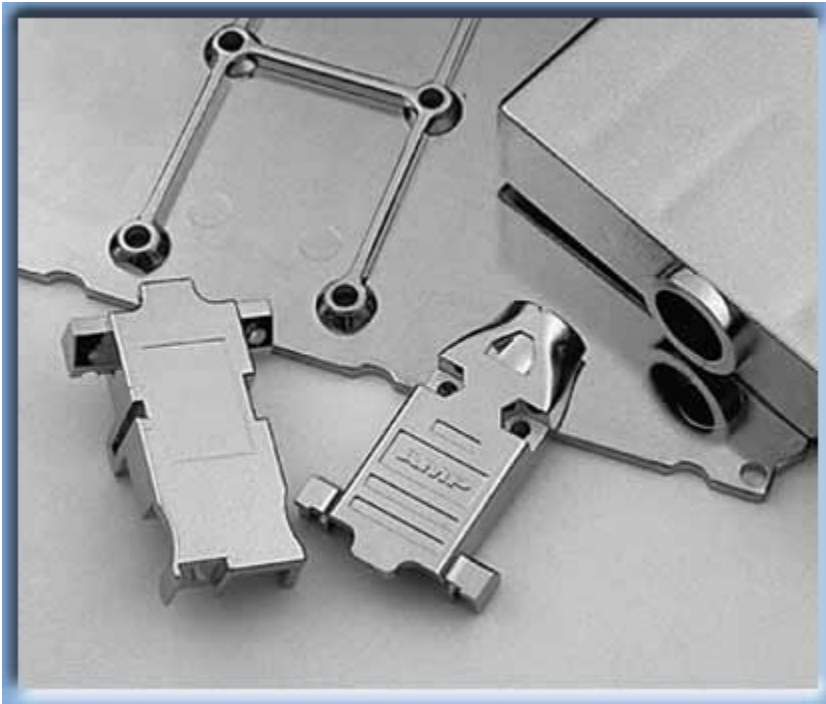
MASKING FIXTURES

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



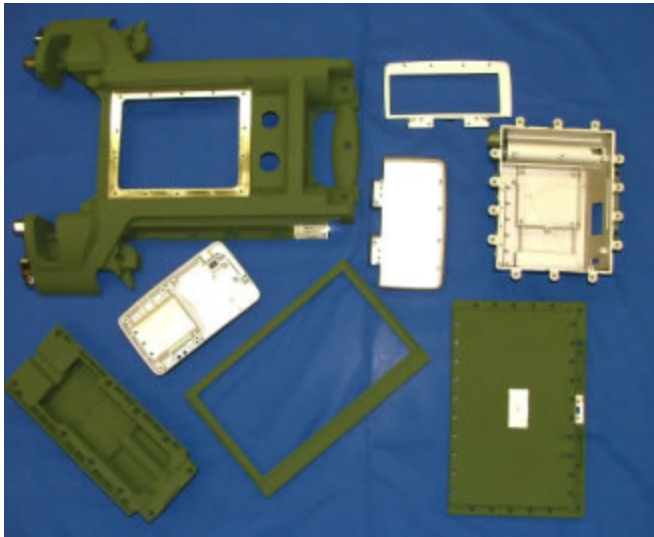
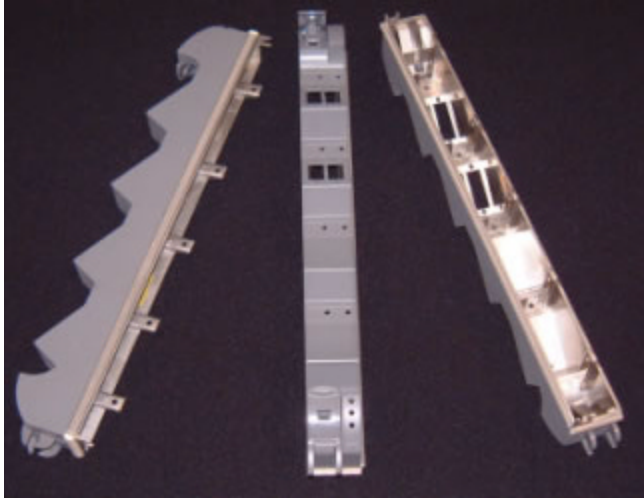
Line-of-Sight Process & Wider Thickness Variation

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 μ m)	5-50	108	120	87
Selective Plating	80-200 μ ” (2.0-5.0 μ m)	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

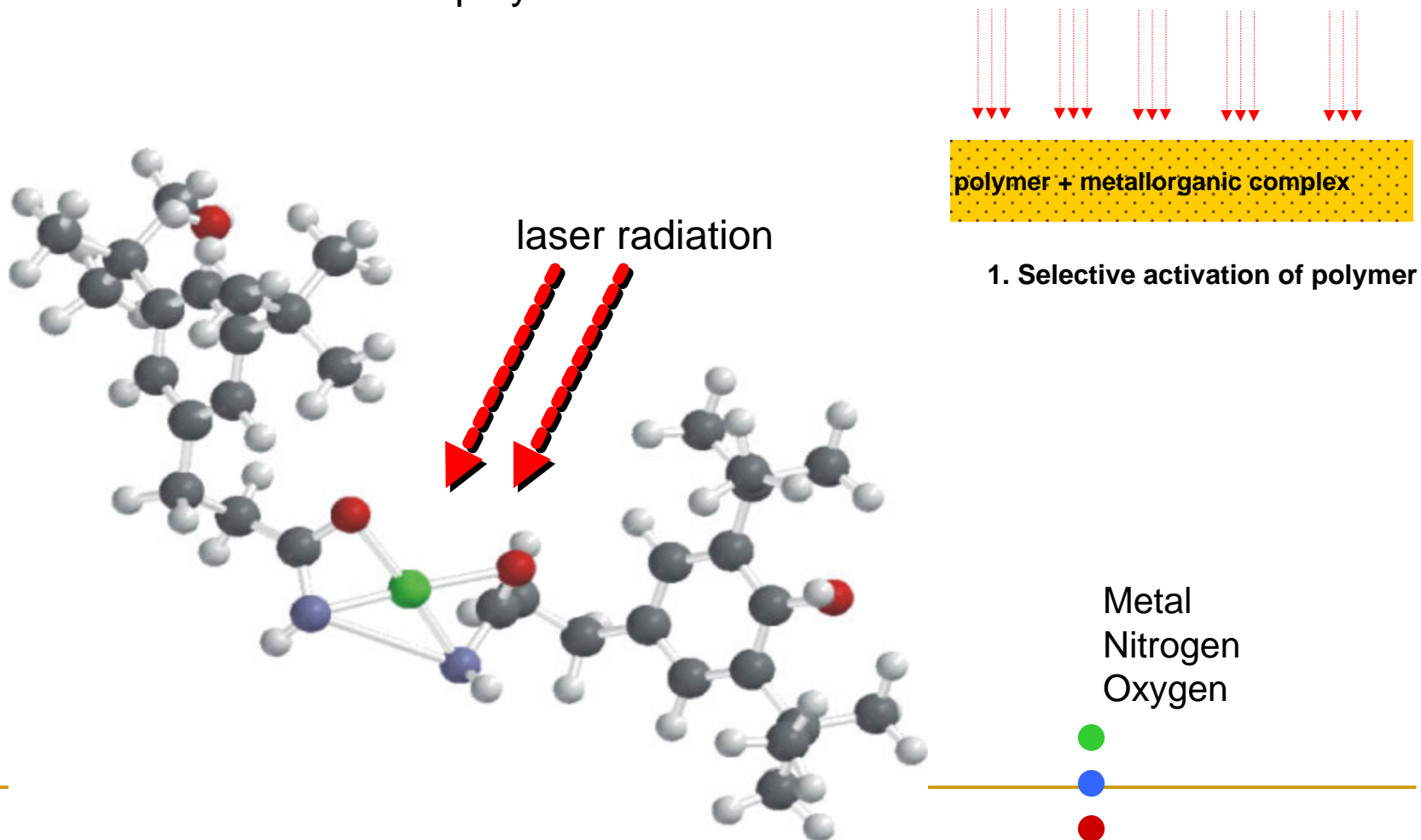
Additive Selective Metallization Process

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



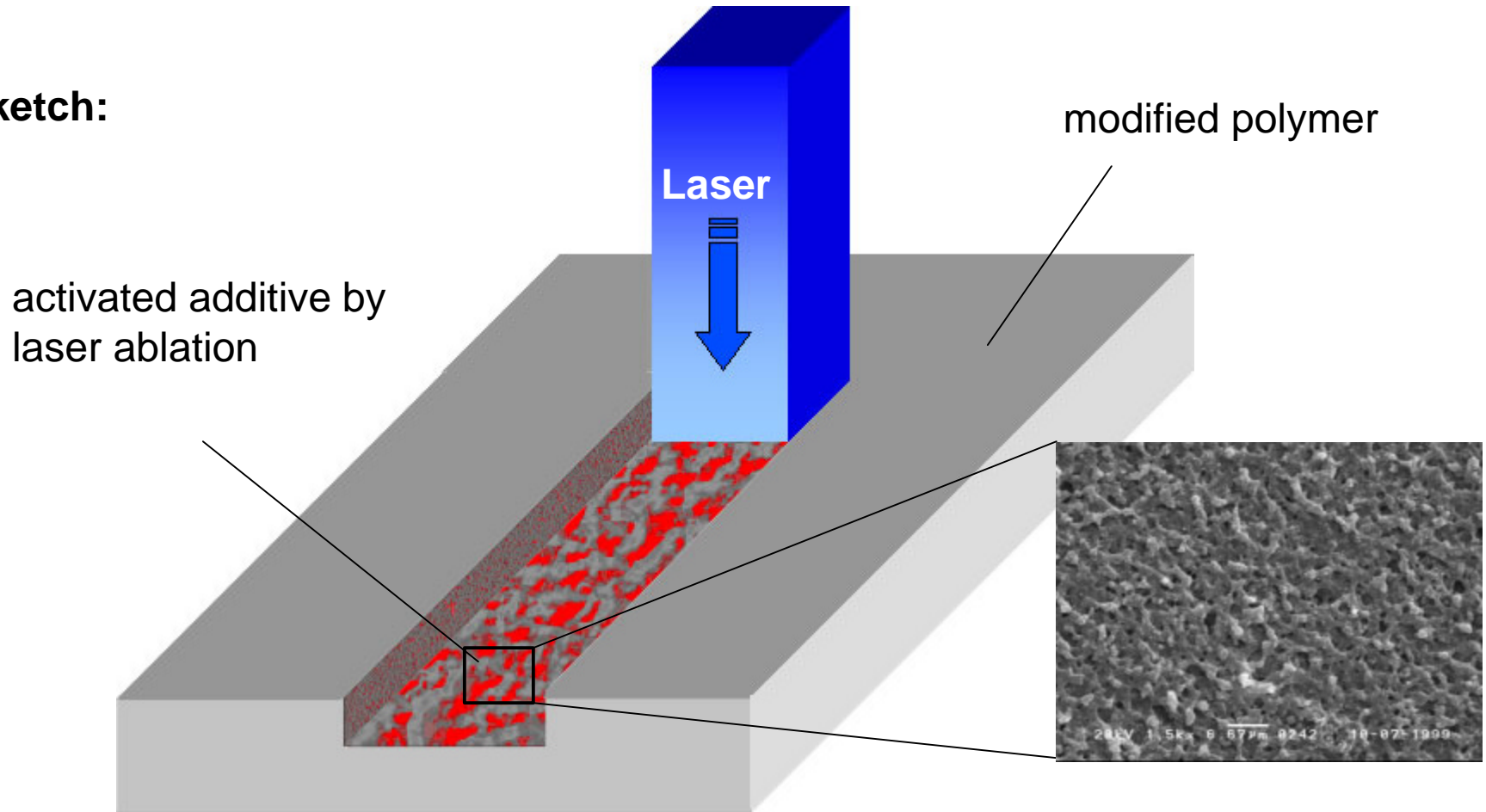
LASER ACTIVATION PROCESS

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



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°

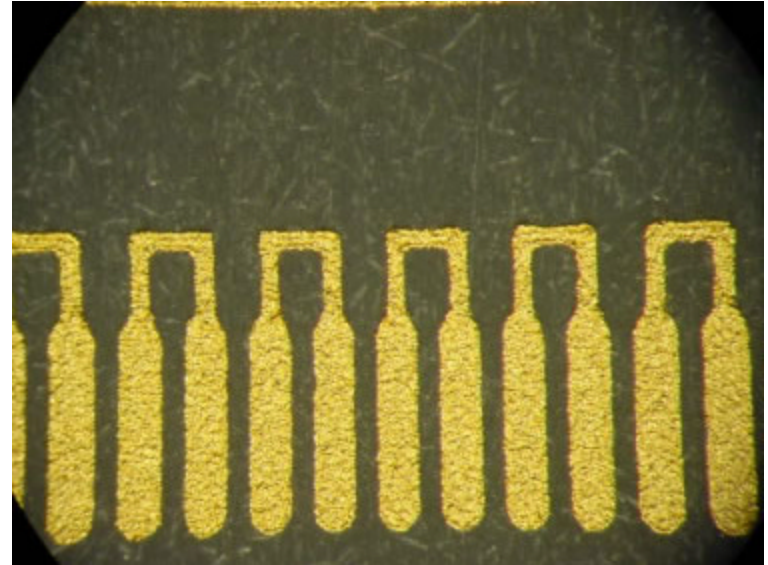
Available Plastic Resins

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



1 mm

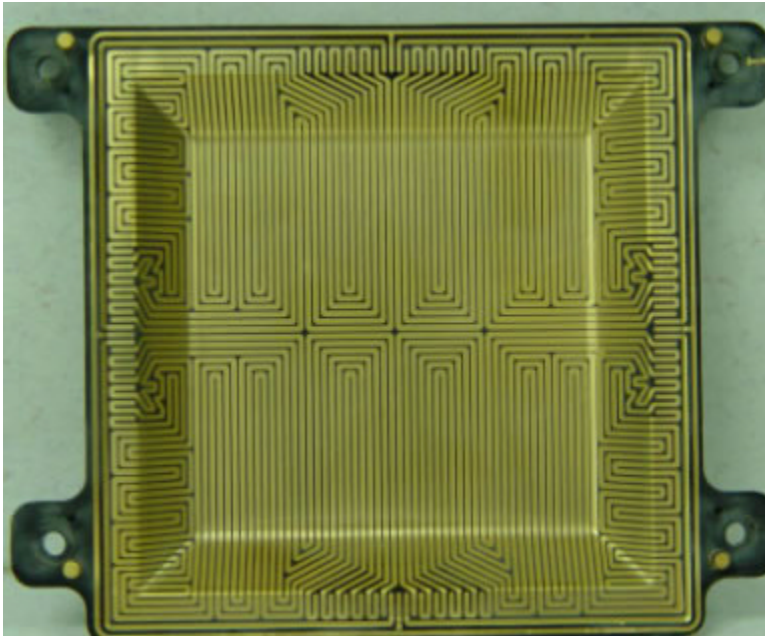


1 mm

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

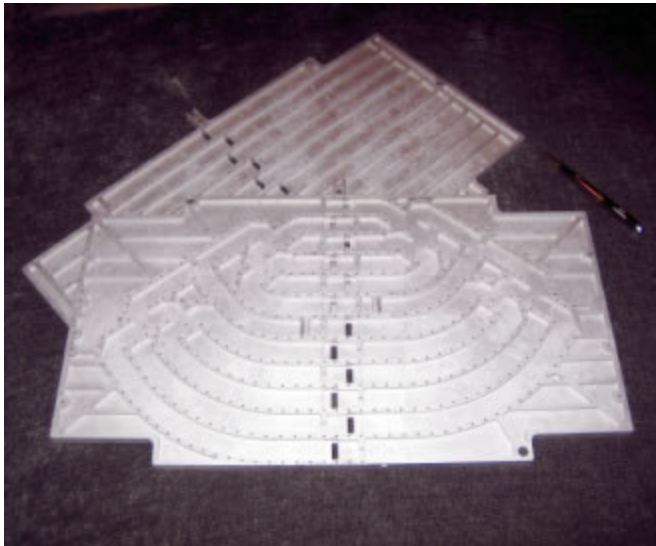
ROUTER CHASSIS



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



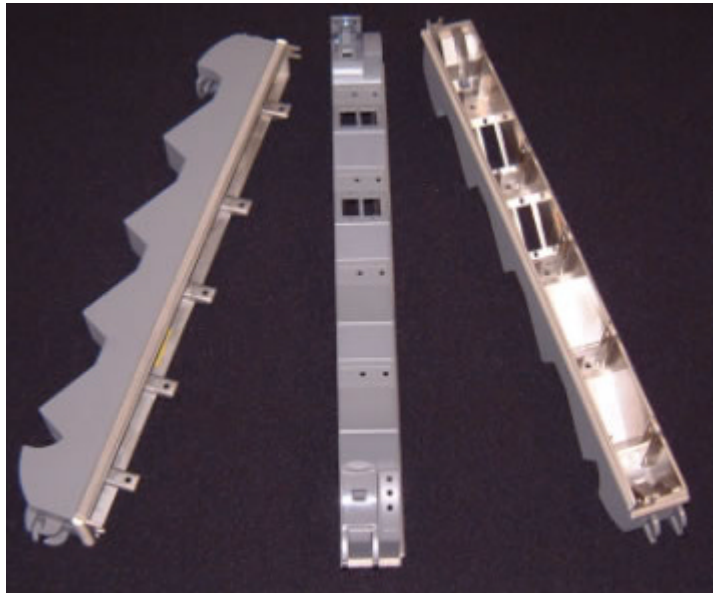
- Mobile Satellite Antenna Waveguide
- Plated with 300 μ " Cu & Ni flash
- Additional Waveguide Applications in Development

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
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