



wavezero

Electronic Shielding

Shielding Packaging for High Cost Electronics

IEEE/CPMT Dinner Meeting
May 11, 2005

AGENDA

- Brief Company Overview
- WaveZero Products
- Performance
- Shield Assembly Process
- Environmental Regulations
- Intellectual Property
- Summary

A PUBLIC COMPANY: LISTED IN THE UK UNDER BLS.L



- Major Operations:
 - HQ, Sunnyvale, California USA
 - North American Manufacturing Center, IL, USA
 - Asia – Pacific Manufacturing Centers, TW & Mainland China (2005)
- Business Sector
 - Engineered Components for EMI Suppression
- Business Applications
 - Shielding Electromagnetic Interference
 - Radio Frequency Identification (RFID)
- Core Competency
 - Metal Coating of Polymers by Vacuum Deposition
 - Design & manufacture products for EMC
- Intellectual Property
 - 8 Patents Granted (U.S.)
 - 24 Patent Applications Filed (U.S. and International)

FORM/MET[®] PRODUCT OVERVIEW



- Form/Met[®] stands for “Formable and Metalizable” shields
- Shields created by thermoforming and die-cutting a lightweight plastic substrate
- Formed and cut shields are then metalized by vacuum metalization
- Replaces inferior solutions such as:
 - Gaskets
 - Conductive paint
 - Soldered metal cans
 - Conductive plastics

PRODUCTS: FORM/MET[®]

Features

- High performance shielding
- Surface resistivity measurements between 0.02 and 0.5 Ohms/Square
- Exceptional design flexibility
- 30 dB to 60 dB of shielding effectiveness typical
- Lightweight and versatile solution

Benefits

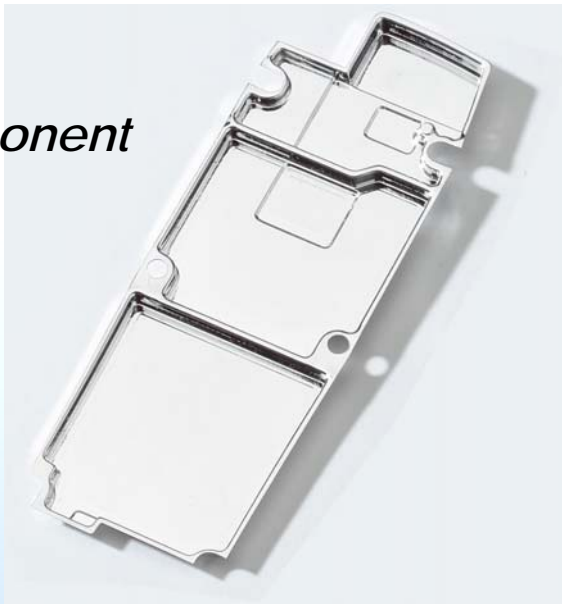
- Recyclable and environmentally sound
- Economical – low total cost of ownership
- Superior supply chain efficiencies
- Rapid time-to-market

PRODUCTS: FORM/MET[®]

- Enclosure Shield
- Board/System Shield
- Component Shield



Component Shield



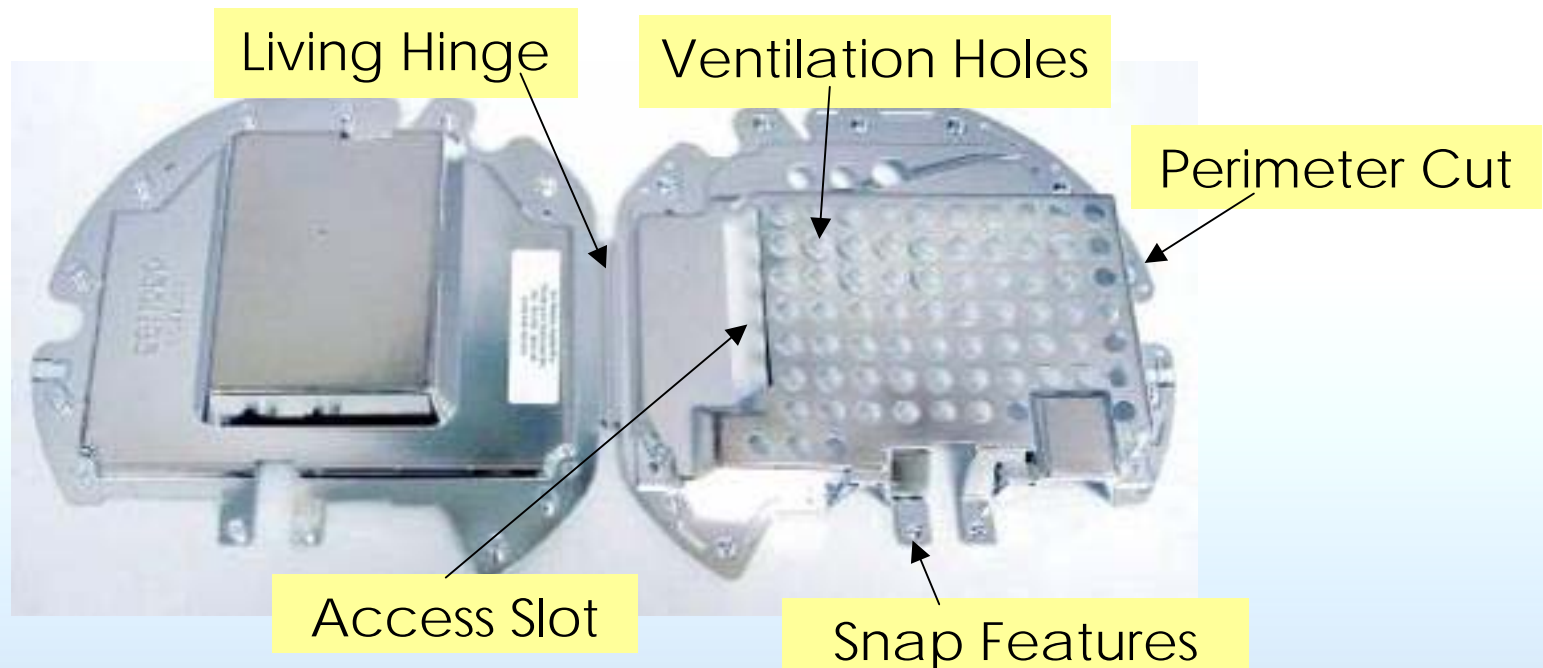
Board/System Shield



PRODUCTS: FORM/MET[®]

Enclosure Shield

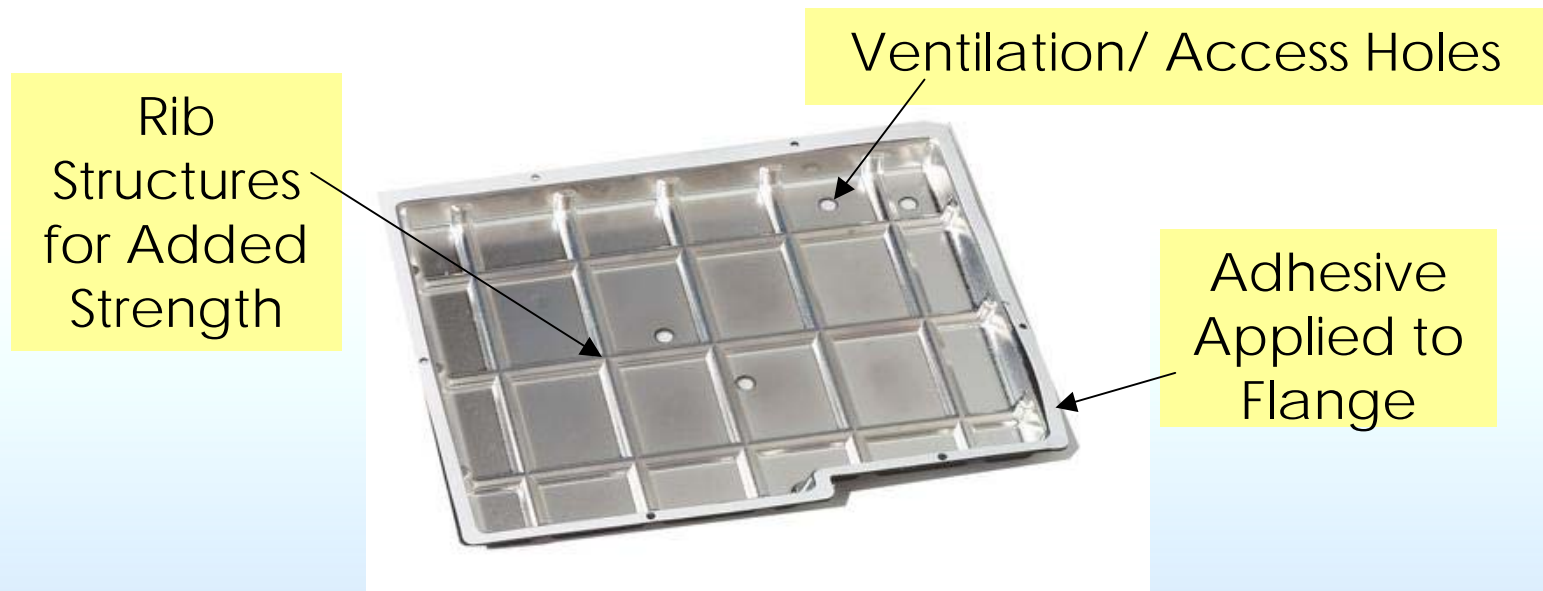
- Completely encapsulates underlying electronics
- Ventilation and access holes easily incorporated
- Various grounding techniques available
- Superior to copper paints and platings



PRODUCTS: FORM/MET[®]

Board/System Shield

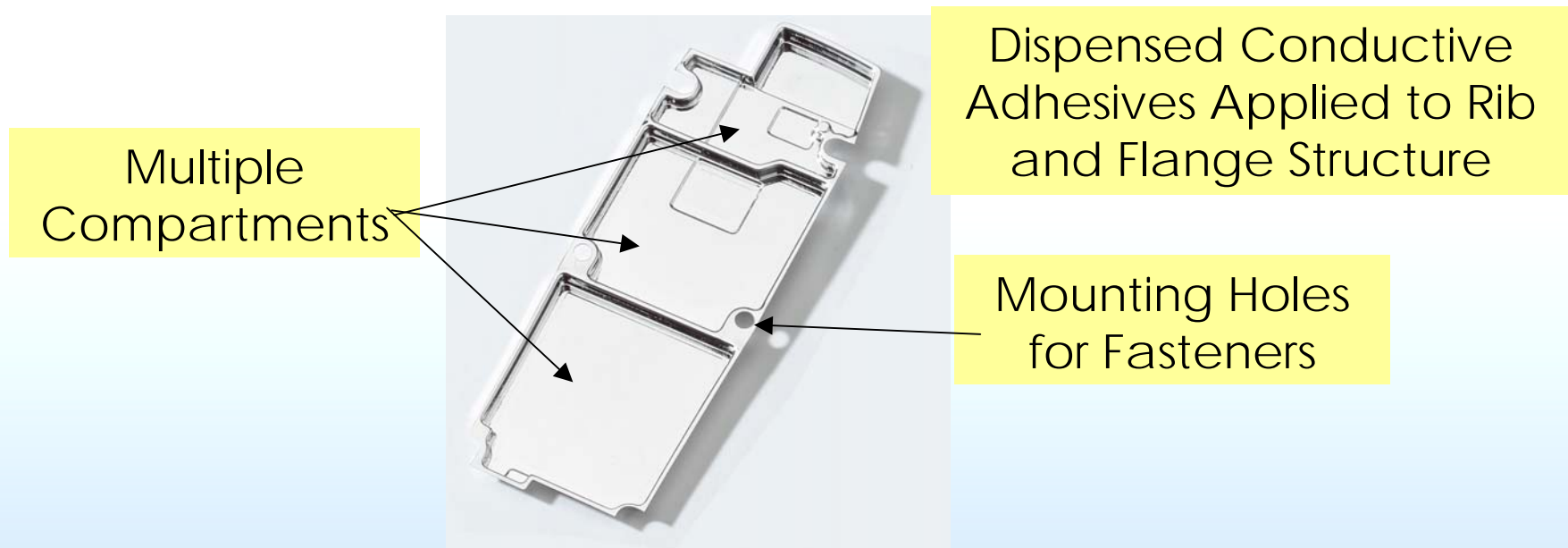
- Shield designs not restricted to straight edges, complex shapes can be integrated into the design
- Ventilation and access holes easily incorporated
- Grounding typically through conductive adhesives or through mechanical fasteners



PRODUCTS: FORM/MET[®]

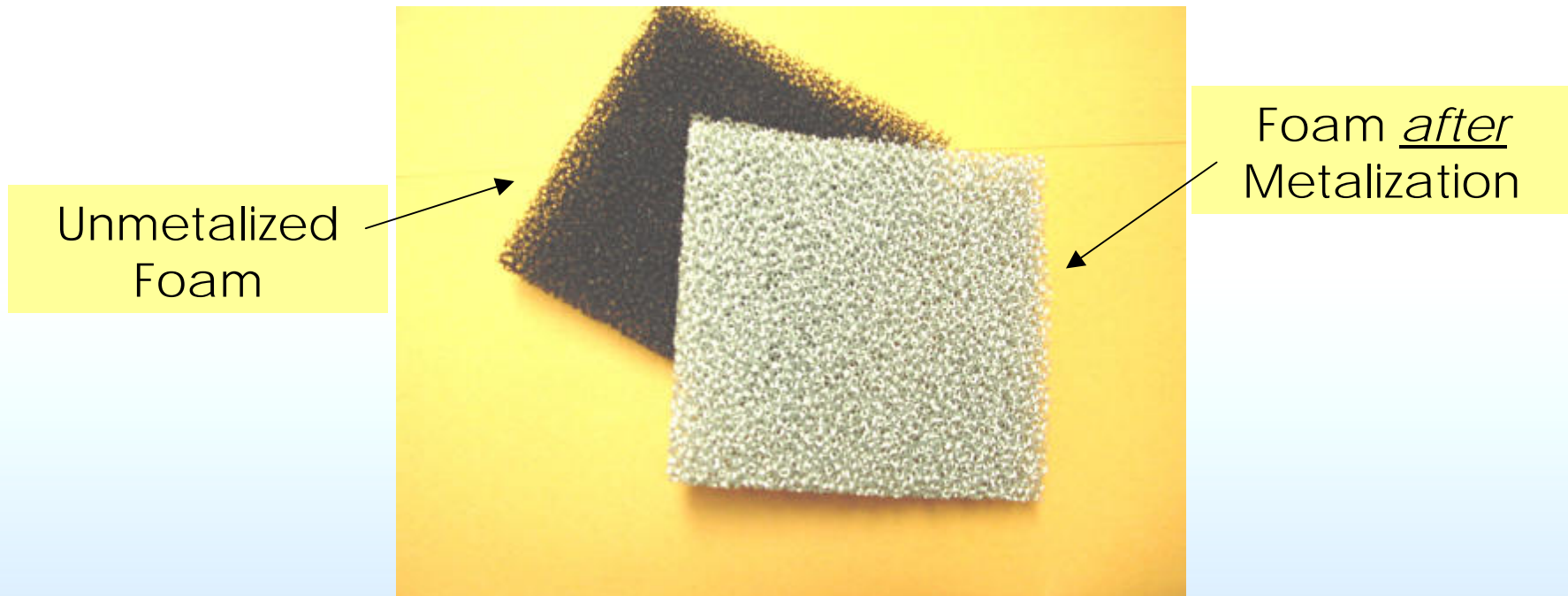
Component Shield

- Shield designs not restricted to straight edges, complex shapes can be integrated into the design
- Ventilation and access holes easily incorporated
- Multiple compartments often incorporated
- Grounding typically through conductive adhesives



PRODUCTS: FLOW/MET[®]

- EMI suppression and air filtration product
- Available in various thicknesses & porosities
- Can be cut to virtually any shape
- Available with flame retardant additives



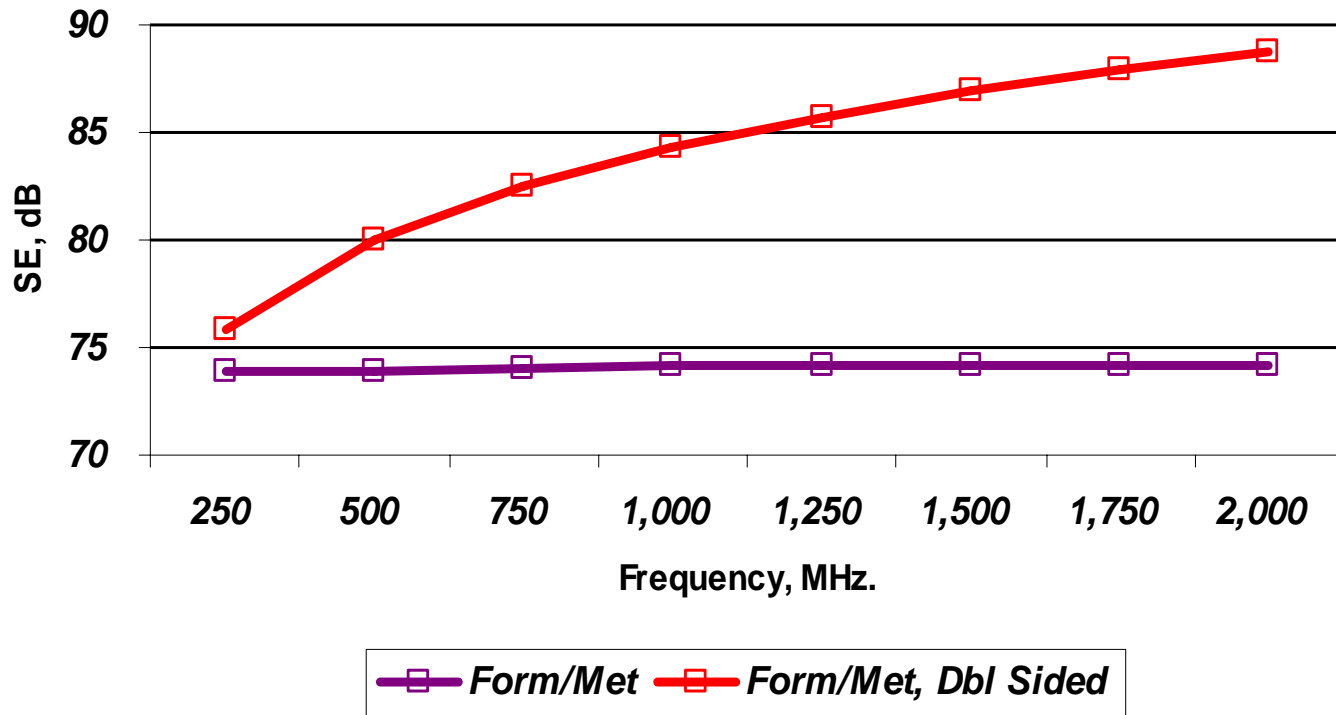
Performance

BASICS OF MULTI-LAYER/ MULTI-MATERIAL



- **Single layer coatings**
 - Thin film coatings primarily reflect energy
 - Thick film coatings provide some additional shielding through absorption
- **Double sided coatings**
 - Film thickness provides additional SE from re-reflection
 - Experimental data correlated with theory
- **Multi-layer, multi-material coatings**
 - Increase interlayer energy losses (more SE)
 - Can be combined to create an optimum system
 - **ss/cu/cu/ss** – good E-field, some H-field shielding
 - Other examples: **ss/cu/ss/ni**, **ss/cu/ss/al**

SHIELDING EFFECTIVENESS*

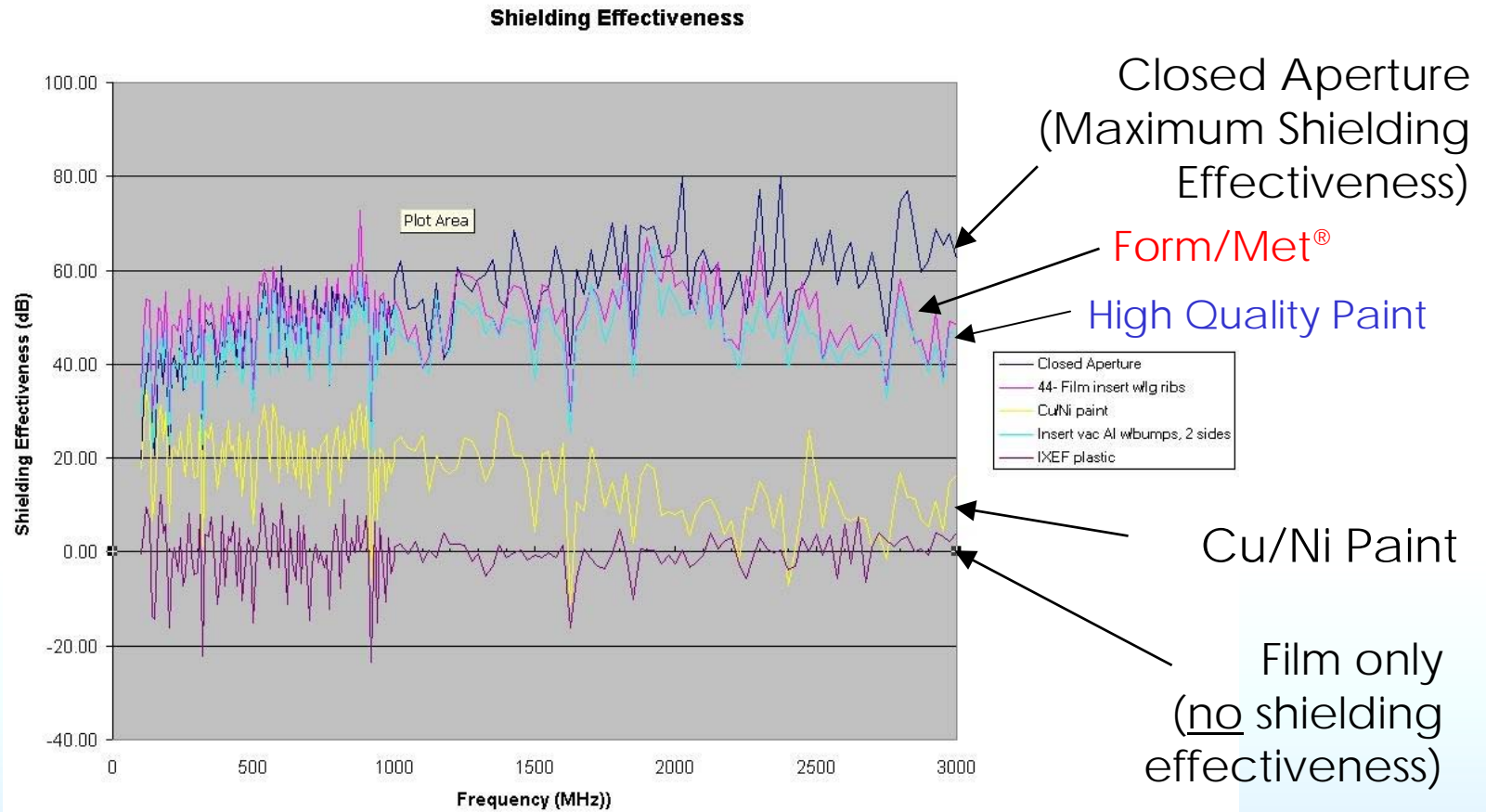


- 75 dB of shielding effectiveness (SE)
- Double sided Form/Met provides additional 5-25 dB of SE

*Before "material" is made into an EMI shield. Based on theoretical analysis.

PDA SHIELD VALIDATION*

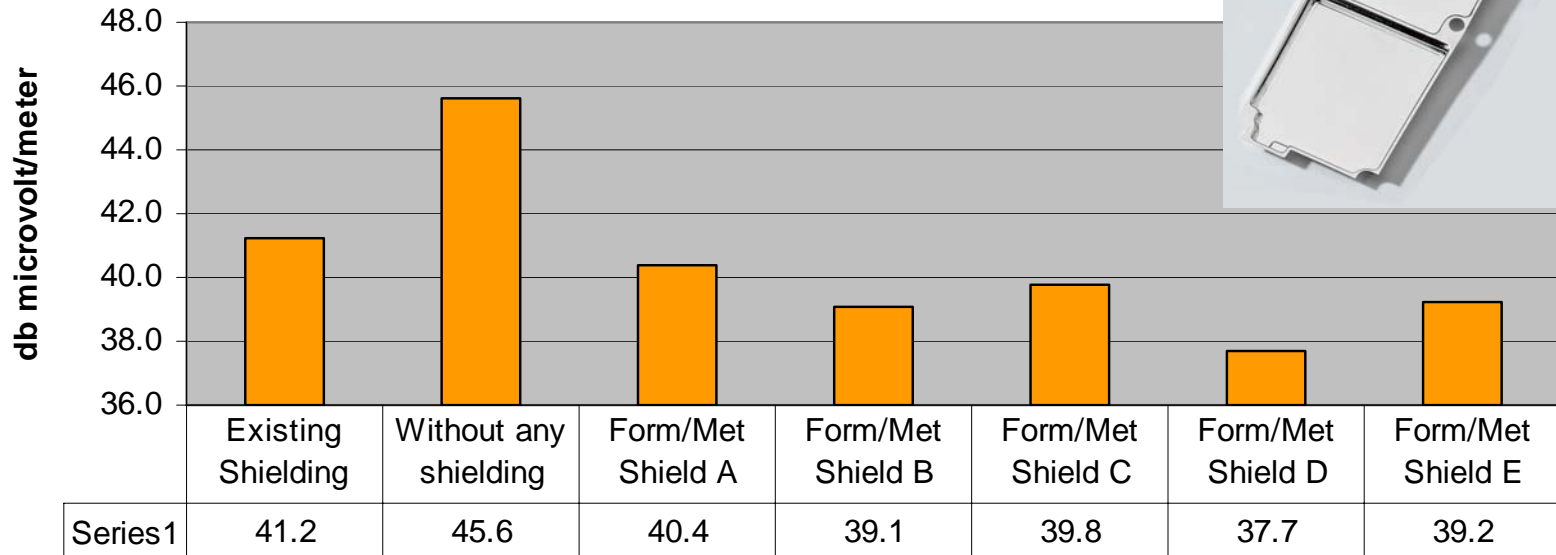
PDA Product



A Variety of Form/Met Designs Were Tested

* Major CEM.

CELL PHONE SHIELD VALIDATION*

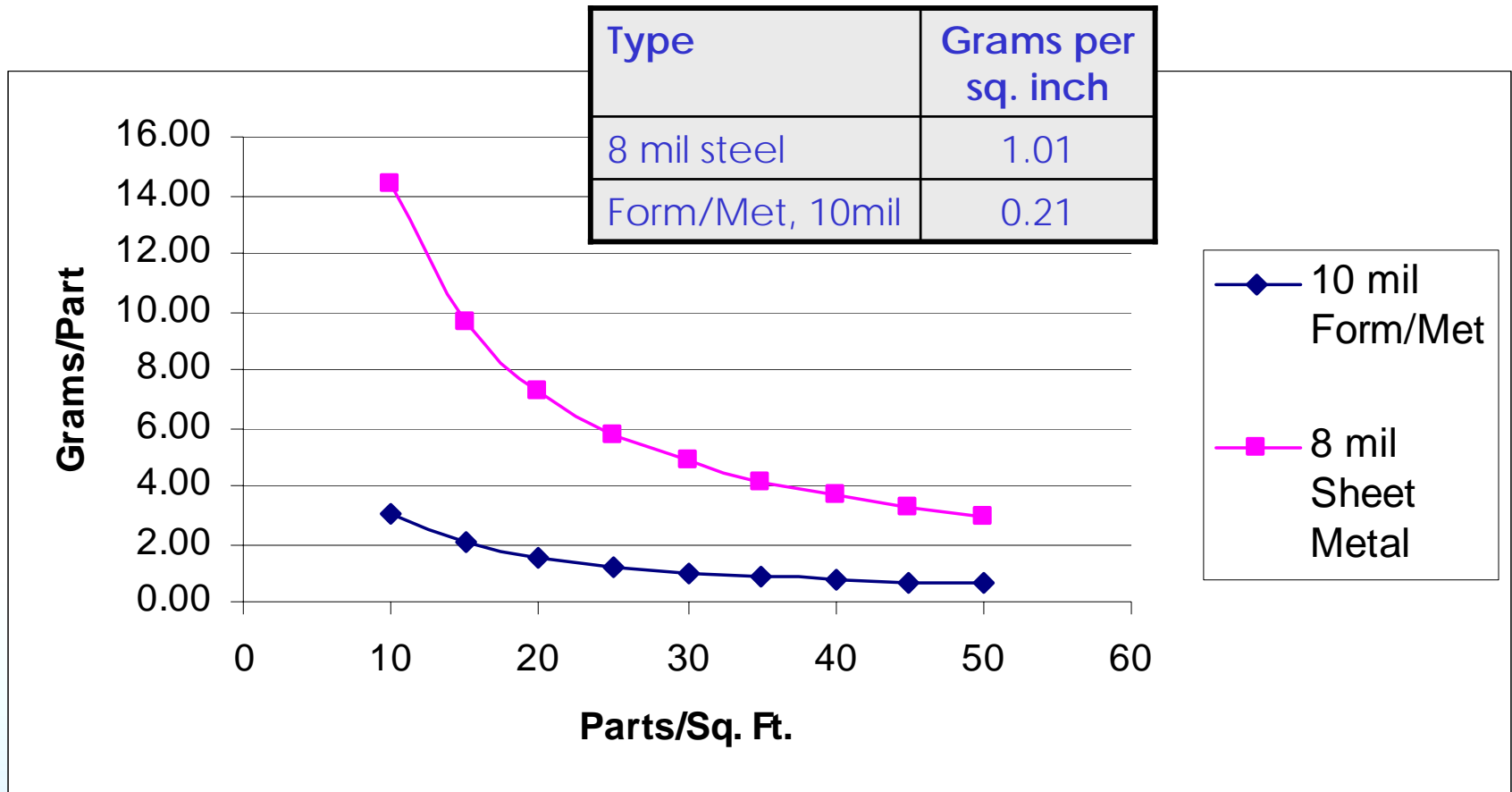


Five designs and mechanical attachments methods were evaluated.

4.2 dB μ V/meter to 7.9 dB μ V/meter improvement over no shield
0.8 dB μ V/meter to 3.5 dB μ V/meter improvement over current shielding

*Elliot Laboratories, Sunnyvale, CA

WEIGHT COMPARISONS



NOTE: 20 square inches of paper (20#) weighs 1 gram.

ADVANTAGES OVER LEGACY SYSTEMS



- Aluminum coating is not toxic
- Vapor deposition is a “green” process well suited for the modern age of environmental regulation
 - Electroplating and painting are not regarded as “green”
- Vapor deposited aluminum creates a virtually stress-free high quality coating
- Metal coating is put on after the part is formed
 - Metal coatings put on before forming create shields that:
 - Have thinned areas (from the thermoforming process)
 - Are not stress-free at room/operating temperatures

Shield Assembly Process

NEW MULTI-CAVITY SHIELDING



Legacy Solution



WAVEZERO Solution



PCB LEVEL COMPARTMENTALIZED EMI SHIELD

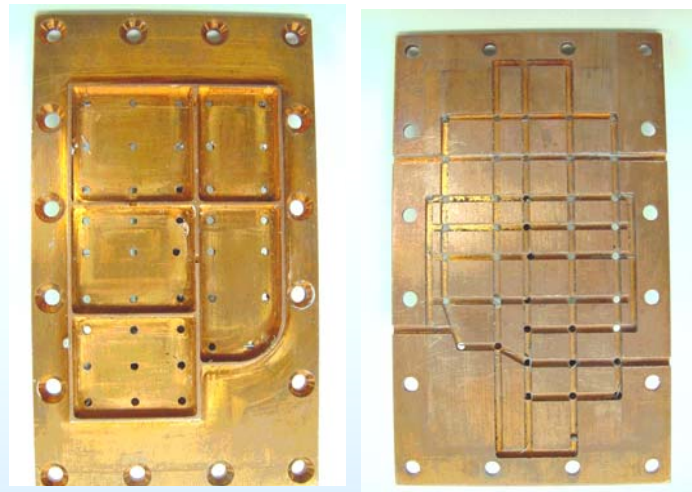
PCB LEVEL SHIELD

- Shield comes with pre-applied, conductive adhesive on flange and rib structures
- Heat and pressure are applied to the shield to create a bond
- Requires ground traces between 1 and 2 mm



ATTACHMENT PROCESS

- Shield Attachment Equipment (SAE) designed to perform following functions:
 - Place EMI shield in curing tool
 - Place shield on PCB and apply heat and pressure to flanges
 - Hold in place; cool down, and retract leaving shield on PCB
 - Cycle time is 45 seconds (GEN1), goal is <15 seconds (GEN3)
- Only the curing tool/cycle changes from one job to the next



REPAIR/RE-APPLICATION

- Form/Met[®] EMI shields are designed for easy removal and repair
 - Removal process in brief
 - Heat bond line slightly to soften thermoplastic ECA
 - Apply uplifting pressure to one corner of shield and remove
 - Re-application
 - Return repaired PCB to regular line for reattachment of shield OR
 - Attach manually using SAE

Environmental Regulations

ENVIRONMENTAL COMPLIANCE (EVC)

- European Union (EU) regulations under discussion for years have been approved
 - Waste Electrical and Electronic Equipment (WEEE) Directive
 - **Full implementation/enforcement August 13, 2005**
 - **Requires “Producers” (not consumers) recover/recycle their electronic products and certify compliance or face penalties**
 - **Makes EVC an economic/competitive factor for OEMs**
 - **Impacts NPI teams who must design electronic products to also minimize/optimize EOL burden to OEM**
 - Restriction on the Use of Hazardous Substances (RoHS) Directive
 - **Full implementation/enforcement July 1, 2006**
 - **Restricts 6 chemicals including, notably, lead using in solder**
 - **Raises potential issues with respect to pure-tin materials**

Intellectual Property

INTELLECTUAL PROPERTY



- 8 awarded U.S. patents surrounding the processing and design of our shields
- 24 U.S. and foreign patents pending
- Numerous trademarks and trade secrets as well:

WaveZero®



Form/Met®

Summary

HISTORIC EMI SHIELDING APPROACHES- CONDUCTIVE COATING ON MOLDED PLASTIC



- **Materials**
 - Copper, silver, nickel, tin often in combination
 - Organic base solvents
- **Processes**
 - Spray painting (VOC emissions)
 - Electroplating (liquid chemical waste)
 - Masks and tools must be cleaned with solvents and liquid/solid waste safely disposed
 - Yield losses result in hard-to-reprocess plastic housings
- **End of Life consequences**
 - 65% of electronic product (by weight) must be recycled
 - Metals must be chemically removed from plastic creating more liquid and solid waste
 - Few opportunities for recycling and reuse of plastic
 - Significant environmental compliance issues and costs
 - Major impact on competitive position vis-à-vis competitors

HISTORIC EMI SHIELDING APPROACHES- wavezero

METAL SOLDERED CANS

- **Materials**
 - Steel, Electroplated tin on steel
 - Lead based solders
 - Prohibited by RoHS after July 1, 2006
 - “No-lead” new solders require higher processing temperatures
 - Potential issues with PCB/can warpage and residual stresses
 - Mechanical reliability problematic until history established
- **Processes**
 - Electroplating tin involves toxic chemicals and liquid waste
 - Soldering traps high value ICs under metal cans
- **End of Life consequences**
 - Demanufacturing/desoldering are costly IF recovery of the underlying (an expensive) IC is the goal
 - Mechanical disaggregation of plastic and metal is possible
 - Further separation of metals complex but possible
 - Compliance costs add to Producer’s total life cycle costs

OUR SHIELDING APPROACH

-FORM/MET[®] EMI SHIELDING



- **Materials**

- Aluminum – not toxic to humans or environment
- Film – compliant with all EU regulations

- **Processes**

- Vacuum metalization (no VOC emissions, no toxic chemicals)
- Masks and tools mechanically cleaned without solvents

- **End of Life consequences**

- Plastic housings
 - Require no chemical process to remove coating
 - Easily recycled by sorting plastic type
 - Plastic can be sold to third parties for reuse
- EMI shield easily removed from PCB or electronic product thus allowing recovery of valuable IC's
- Recycling of shield by various means
 - Return to WaveZero for final processing (reuse in new shields)
 - Ground up and sold to extruders who can tolerate 1% aluminum
 - Placed in approved dump or burned for energy

SUMMARY

- Solid public company
- State of the art mature volume manufacturing
 - North America & Asia-Pacific
- Extensive customer base including CMs
- Complete EMI suppression products solutions
 - Highly price competitive against legacy products
 - High technical performance & production integration
 - Worldwide Environmental Compliance
 - Readily adaptable technology to new applications
 - High scalability across a wide range of sizes, shapes & volumes