Package Trends for Mobile Device

On-package EMI Shield
At CTEA Symposium

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TEL NEXX, Inc.
Love Thinner Mobile?

iPhone at its largest. And thinnest.

iPhone 6
Bigger than bigger

http://www.apple.com/ iPhone is registered trademarks of Apple Inc.
Outline

- Evolution of EMI shielding technology
- Advantage of PVD for on-package EMI shield
- TEL NEXX technologies
- PVD process solution
- Summary
Package trends towards smaller implementation size and height, One of next steps moving to EMI Shield Design for Packages
EMI Shielding Trends, Packaging Technology

Dr. Harrison Chang, Vincent Chen, USI at SEMICON West 2013, Edited

Shielding in Mobile

Older Metal Can Shields may not always be the Answer

http://www.semi.org/
Discussions for Mobile Device

- Noise is Wideband, and Shielded Package Reduces Interference for EMC
- Compartmentalization Limit Resonance to Higher Frequencies
- Affect Shielding Effectiveness
  - The Conductivity of Shielding Material and Shielding Thickness. The Grounding of the Shielding Structure

Shifting to Package level of EMI Shield

Keys [Conductivity of Material and thickness] [Grounding structure]

Dr. Harrison Chang, Vincent Chen, USI at SEMICON West 2013, Edited  http://www.semi.org/
EMI Shielding Trends, Packaging Technology

- PCB space savings with RFMD’s MicroShield

- Thinner system assembly with EMI shield on package
- Design Layout Flexibility on Mobile Main PCB

Source: AN RFMD® WHITE PAPER
Shielding RF Components at the Package Level
## iPhone 6 Teardown

### The front side of the logic board:
- Apple A8 APL1011 SoC + SK Hynix RAM as denoted by the markings H9CKNNN8KTMWR-NTH (we presume it is 1 GB LPDDR3 RAM, the same as in the iPhone 6 Plus)
- Qualcomm MDM9625M LTE Modem
- Skyworks 77802-23 Low Band LTE PAD
- Avago A8020 High Band PAD
- Avago A8010 Ultra High Band PA + FBARs
- SkyWorks 77803-20 Mid Band LTE PAD
- InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo

### Back side of the logic board:
- SanDisk SDMFLBCB2 128 Gb (16 GB) NAND Flash
- Murata 339S0228 Wi-Fi Module
- Apple/Dialog 338S1251-AZ Power Management IC
- Broadcom BCM5976 Touchscreen Controller
- NXP LPC18B1UK ARM Cortex-M3 Microcontroller (also known as the M8 motion coprocessor)
- NXP 65V10 NFC module + Secure Element (likely contains an NXP PN544 NFC controller inside)
- Qualcomm WTR1625L RF Transceiver

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Multiple on-package EMI shield launched

[Link](https://www.ifixit.com/Teardown/iPhone+6+Teardown/29213)

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# EMI Package Metal Shield Process Methods

<table>
<thead>
<tr>
<th></th>
<th>Plating</th>
<th>Spray</th>
<th>PVD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros</strong></td>
<td>• Common process for Plastics</td>
<td>• Smaller product</td>
<td>• Controllability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relatively low cost product</td>
<td>• Low film resistivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Less Process Steps</td>
</tr>
<tr>
<td><strong>Cons</strong></td>
<td>• Product Masking</td>
<td>• Product Masking</td>
<td>• Less Sidewall Coverage</td>
</tr>
<tr>
<td></td>
<td>• Large product footprint</td>
<td>• Thickness variation</td>
<td>• Adhesion to plastics</td>
</tr>
<tr>
<td></td>
<td>• Initial facility cost</td>
<td>• High cost of material</td>
<td>• Backside deposition</td>
</tr>
</tbody>
</table>

Manufacturers are always looking for the Best Technology & Economic Solution
EMI Shield Package Outlook

• Motivation with Mobile
  – Thinner package fabrication
  – Local noise interference reduction due to higher & several frequency device mix

• Packages and EMI methods
  – Wi-Fi/BT, GPS → RF, Memory → Application processor
  – Plating / Painting method shifts to PVD

• PVD advantages
  – Better film properties
  – Lower Cost of Ownership
## TEL NEXX Company Overview

### Products
- Deposition equipment for advanced packaging (ECD & PVD)

### Target Markets
- High-end semiconductors used primarily in mobile devices; LEDs

### Location
- Billerica, Massachusetts

### Support
- Worldwide Offices: China, Taiwan, Korea, Japan, Singapore, Europe

### Products
- **Stratus (ECD)**
  - Electrochemical Deposition
- **Apollo (PVD)**
  - Physical Vapor Deposition

### Applications
- **Stud or Pillar**
- **Bump**
- **Under Bump**
- **Backside Metal**
- **LED Contacts**
TEL NEXX Products for Advanced Packaging

Wet and Dry Metal Deposition

Stratus
Electrodeposition (ECD)

Apollo
Physical Vapor Deposition (PVD)

TEL NEXX has expanded its Advanced Packaging Offering

NEXX Products
EMI Package Metal Shield Requirements

- Shielding performance
- Highly Conductive Metal Film
- Laser Mark Visibility
- Adhesion to Package
- Side Wall Coverage
- Low Resistance to GND
- Protect Backside Contact
- Control Process Temperature
- Long Life
- Reliable
- Low Cost

Figure source: Toshiba Review Vol.67 No.2 2012, Edited
## EMI Shielding PVD Process Flow

<table>
<thead>
<tr>
<th>Seq.</th>
<th>Operation</th>
<th>Key Process Inputs</th>
<th>Impact on Process Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load</td>
<td>Package Placement</td>
<td>Electrical Performance, Sidewall Coverage, Appearance</td>
</tr>
<tr>
<td>2</td>
<td>Degas</td>
<td>Temp, Time, Cool Time, Base Pressure</td>
<td>Package Temperature, Adhesion, Electrical Performance</td>
</tr>
<tr>
<td>3</td>
<td>Pre-treatment</td>
<td>Time, RF Power, Process Gas Flow, Base Pressure</td>
<td>Package Temperature, Adhesion, Electrical Performance</td>
</tr>
<tr>
<td>4</td>
<td>Deposition</td>
<td>Power, Time, Process Gas Flow, Base Pressure</td>
<td>Package Temperature, Adhesion, Electrical Performance, Sidewall Coverage, Metal Thickness</td>
</tr>
<tr>
<td>5</td>
<td>Unload</td>
<td>Package Placement</td>
<td>Safety, Contamination</td>
</tr>
</tbody>
</table>
Trials for EMI Shield on Package

Package:
Coated with EMI shield + Corrosion barrier by PVD(Apollo)

Package:
Post Cut & Tape test

Tape:
Post Cut & Tape test

PVD EMI shield film/Corrosion barrier shows excellent adhesion to various commercial package surfaces
Summary

• EMI Shielded package can be a solution towards thinner implementation for Mobile devices

• Wi-Fi/BT modules, PA modules and Memory inside the latest high-end mobile were fabricated on-package EMI Shielding

• PVD is one of the better solution for on-package EMI Shielding