Trends and Challenges in Semiconductor Advanced Packaging

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Agenda

1. Amkor Introduction
2. Advanced Packaging Trends
3. Advanced Packaging Challenges
Amkor Introduction
Amkor by the Numbers

- Founded in 1968
- $4.1B Net Sales*
- 30,000 Employees
- $475M CapEx*

End Markets
- Automotive
- Communications
- Industrial
- Computing
- Consumer

Footprint in 11 countries

11,000,000 Square Feet of Manufacturing Space

*2019 results
Amkor in the Supply Chain

- Materials
- Wafer Fab
- HDFO 2.5D H.I.
- A/T
- SiP
- EMS

New OSAT TAM
Broad Geographic Footprint
11 million square feet of manufacturing space

- **Korea**: 3.9M sf
- **Japan**: 2.0M sf
- **Taiwan**: 1.1M sf
- **Philippines**: 1.3M sf
- **Malaysia**: 0.4M sf
- **Shanghai**: 1.3M sf
- **Portugal**: 0.5M sf
- **Singapore**: 1.3M sf
- **United States**: 2.0M sf
Flagship Factory – Incheon Korea

- 2.3M $ft^2$ on 46 acres
- >6,000 employees
- R&D Center
- Advanced packaging
- Green building
Advanced Packaging Trends
Key Growth Catalysts

5G
Mobile Communications
Connected Devices
Automotive
Speed, Streaming

Automotive
Autonomous Driving
Infotainment
Electrification
Safety

IoT
“Smart Everything”
Connected Home
Wearables
Industrial Automation

Networking
Data Center
Analytics
High Performance Computing
Artificial Intelligence
Advanced Packaging in Your Smartphone

Requirements

▶ Smaller footprint, minimum height
▶ Wafer level packaging
▶ 3D structures
▶ Multi-die packages
▶ Signal integrity
Enabling New Applications in the Car

- Zero defect mindset
- High reliability requirements
- Reduced time to market
- New package configurations
- Advanced packaging adoption

Advanced Packages
- SIP
- FCBGA
- Infotainment
- ADAS
- WLFO
- Powertrain
- Power

Wirebond Packages
- SOIC
- Body Electronics
- EV/HEV
- QFP
- Chassis
- QFN

Powertrain Packages
- WLFO
- ADAS
- Power

Environment
IoT Made Possible

Multiple Applications
- Connectivity
- Sensing
- Computing
- Storage

Diverse Requirements
- Power
- Bandwidth
- Integration
- Security

Scale
- Amkor ships billions of IoT devices per year!
Big Data Requirements

Data Center
HPC, AI, ML
Thermal Management
FCBGA, HDO, SiP

Networking
High-Speed Switch
Logic + Memory Integration
SiP, HDO, 2,5D

Storage
Solid State Drive
Memory Die Stacking
Stack CSP, WBBGA, SiP
Advanced Packaging Challenges
Advanced Packaging Platforms

- **Chip Scale to Fan-Out**: Wafer
- **MEMS**: Laminate, LF & Wafer
- **Flip Chip**: Laminate
- **Heterogeneous Integration**: Laminate or Wafer
- **System in Package**: Laminate

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MEMS

IoT, wearables & industrial
- Sensor fusion
- Low power, form factor & cost
- System & functional integration
  » Many die, broad packaging toolkit required

Laminate, LF & Wafer
Amkor’s 3D & 5G Packaging Innovation
Packaged Embedded Die: Large complex modular systems

- Multi-die + Package Stacking
- Multi-level Packaged Embedded Die
- Compartmental/Conformal Shield & Dual Side Mold
- Antenna in Package
- Advanced System Integration
- Partial Mold with Partial Shield

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Significant R&D Investment

- Outstanding engineers
- Localized design services
- Dedicated assembly lines
- Complete toolbox of engineering services
- Continuous innovation
Supply Chain: Globalization to Localization?

Before
- Global production networks
- Global supply chain networks
- Minimized stock strategies
- Global delivery footprint
- Customer-specific variant
- Limited risk management

After
- Localized production networks
- Local supply chain networks
- Local warehouse and reserve strategies
- Build where you sell
- Variant reduction
- Expect the unexpected

The Future of Advanced Packaging

- Innovation milestones
  - Multi-sided assemblies
  - Advanced materials
  - Electrical microsystems
  - Extreme density

- High capital outlays
- Pace of change is accelerating
- Time to market is critical
- Heterogeneous packaging will extend Moore’s Law