Status of the Advanced Packaging Industry: 2015

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FROM TECHNOLOGIES TO MARKET

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## TABLE OF CONTENTS

- **Introduction, Definitions & Methodology**
- **Scope & Objectives**
- **Executive Summary**
- **Market drivers**
  - Advanced Packaging drivers
  - AP Market and Technology trends
- **Market forecasts**
  - Overview
  - Smartphone split by platform and teardowns
  - Revenue forecast
  - Wafer count forecast
  - Unit count forecast
  - IC type split per package type
  - Wafer size split
  - Capacity increase forecast
- **Players and Supply Chain**
  - Semiconductor industry:
    - Overview
    - Financial analysis
    - M&A activity
  - Market shares
  - Company split by AP platforms
- **Packaging Segmentation**
  - Segmentation by die to board features
  - Package feature trends
  - Price comparison
- **Reflections and Case Studies**
  - 2.5D / 3D adoption
    - Latest products and announcements
  - FO WLP adoption
    - TSMC inFO analysis
    - eWLB latest product
  - FI WLP evolution
    - Selected product
  - Packaging for Internet of Things
    - The semiconductor packaging business landscape
    - Packaging requirements
- **Conclusion**
Overview of Advanced Packaging trends, technology, production, market shares and financial insight

The 1st Edition of the “Status of the Advanced Packaging Industry” report from Yole Développement brings a thorough analysis, including:

- Recent **dynamics and disruptions** that marked the advanced packaging industry
- **Market forecasts** per packaging platform and device type, from 2014 to 2020
- New **market shares** by business model, wafer size and application
- Supply chain analysis and **financial evolutions, M&A**
- Current **packaging technology segmentation and trends**
- Reflection on IoT and adoption of **2.5D/3D and Fan-Out products** and **Fan-In evolution**
Scope of this report: Fan-In and Fan-Out WLP, Flip Chip and 2.5D/3D

- Leadframes
  - QFN/QFP
  - Fan-in
  - Fan-out
- w/o IC substrates
- IC substrates-based
  - BGA (organic substrate)
  - Embedded die (in substrate)

Focus of this report

* SiP and PoP are not treated separately and are considered as alterations and/or advanced features of existing platforms
REPORT OBJECTIVES

To provide a high level market overview of the Advanced Packaging landscape
- Identify Advanced Packaging drivers and trends
- Current status and forecasts until 2020: Revenue, wafer count, unit count
- Identify main players and provide supply chain analysis
- Market shares by business model, wafer size and applications
- First level financial insight and related industry segmentation

To provide analysis of technology trends
- Packaging segmentation
- Package feature trends
- Price comparison

To assess the future development of the Advanced Packaging market
- Outlook on potential disruptions: new market drivers, infrastructure, expanding business models, new entries, competing packaging solutions
- Impact on supply chain and technology roadmap
COMPANIES CITED IN THE REPORT

Transistor scaling and cost reduction will not continue on the same path – reaching sub 10nm grey zone

WHAT ARE THE OPTIONS?

• Continue with development of advanced technology nodes (follow Moore’s Law)

• Develop new alternative technologies/packages (More than Moore) to meet the market requirements

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Bridging the Gap Between Si and PCB Processing Capabilities

Increase in Packaging Technology Solutions

Feature sizes of PCBs

Surface Mount

SOP, QFP, PLCC

Through hole

DIP, PGA

Ball grid arrays

SiPs

Fan-in WLP

FC BGA

PoP

More SiPs

Interposers

3D IC

TSV

FO WLP

Feature sizes CMOS

1970
1980
1990
2000
2010
Today

Packaging technology evolution

1980
1990
2000
2010
Today

Gap Features Si vs PCB

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The semiconductor industry is facing a new era:

- FEOL transistor scaling and cost reduction will not continue on the same path they followed for the past few decades, with Moore’s law in its foundation.
- Advanced technology nodes do not bring the desired cost benefit anymore and R&D investments in new lithography solutions and devices below 10 nm nodes are rising substantially.

New market shifts are expected in due time, with “Internet of Things” getting ready to take over pole market driver position from mobile.

Why Advanced Packaging?

- While FEOL scaling options remain uncertain and IoT promises application diversification, the spotlight is now turned to advanced packages for:
  - Cost reduction
  - Performance boost
  - Functionality boost
- In order to answer market demands, the advanced packaging segment focuses on integration and wafer level packages.

Advanced packaging is transitioning to high-performance, high-density, low-cost collective wafer level packaging techniques.
THE GROWTH OF ADVANCED PACKAGING

• Emerging packages aim to bridge the gap and revive the cost/performance curve while at the same time adding more functionality:
  - SiP
  - 2.5D / 3D IC
  - Fan-out WLP

• Historically supported by flip-chip wafer bumping, today, Advanced Packaging can offer several solutions, such as: copper pillars, fan-in WLP, specific MEMS and CIS packaging, fan-out WLP, embedded technologies and more recently, 2.5D interposers and 3DIC with TSV interconnects

  * Fan-in WLP remain a constant presence amongst emerging packages with unmatchable attractive features
  * Its specific advantages – primarily low cost and minimum form factor remain to be engaging for more than a decade
  * Flip Chip packages cover the majority of advanced packaging production and represent a mature and reliable supply chain

Source: ASE, SemiconWest

While Fan-Out WLP and 2.5D/3D IC platforms are positioning themselves for high volume production, Flip Chip packages still cover the majority of Advanced Packaging production with fan-in WLP maintaining appeal and still on an evolutionary track

Source: ASE, SemiconWest

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WHAT’S NEW ON THE MARKET SINCE LAST YEAR?

Market dynamics

• The semiconductor industry is going through an era of consolidation
  • High M&A activity present

• The Internet of Things is starting to stir the packaging market
  • Packaging options are being explored as new applications arise

• Foundry involvement is no longer a dent in AP production
• Increased activity of Chinese capital on the market
WHAT’S NEW ON THE MARKET SINCE LAST YEAR?

Market trends

- As mobile sector continues to drive IC production, IoT looms on the horizon
- The semiconductor industry consolidates preparing for new applications and technologies
  - High M&A activity present
- IoT market and application segmentation commences
- New applications are emerging while other are declining
- Increased activity of Chinese capital on the market in order to decrease external dependency and establish a full internal semiconductor supply chain

=> **Mobile sector is driving production** and growing, however, a **new market driver - IoT** is on the horizon and is expected to have a significant impact on the packaging industry as a whole
WHAT’S NEW ON THE MARKET SINCE LAST YEAR?

Technology trends

- IoT steers towards application oriented roadmaps while scaling continues to drive performance roadmaps
- Packaging requirements and technology segmentation for IoT emerges as hot topic
- As FEOL scaling roadmaps bring rising cost and feasibility concerns, the spotlight turns to advanced packages:
  - Seeking continuation of Moore’s law
  - For functional integration driven by future applications
- In order to answer market demands - combine cost reduction, performance and functionality boost - the advanced packaging segment focuses on integration and wafer level packages:
  - Start of first volume 2.5D / 3DIC products outside of MEMS and CIS
  - Rising activity in Fan-Out development and SiP solutions
- Main advanced packaging technology drivers and innovation:
  - Increased integration
  - Reduced form factor
  - Low cost

=> Mobile sector is driving fan-in WLP production and growing, however, a new market driver - IoT is on the horizon and is expected to have a significant impact on the packaging industry as a whole
ADVANCED PACKAGING OVERVIEW 2014 vs. 2020

Revenue

2014 Advanced Packaging REVENUE SPLIT

2020 Advanced Packaging REVENUE SPLIT

WAFFER split

2014 Advanced Packaging WAFFER SPLIT

2020 Advanced Packaging WAFFER SPLIT by wafer count

UNIT split

2014 Advanced Packaging UNIT SPLIT

2020 Advanced Packaging UNIT SPLIT
AP PLATFORMS IN MOBILE DEVICES

Overview by applications

- **Drivers**
  - Devices packaged using ‘Fan-in’ WLP
  - Devices that can be found in both ‘Fan-In’ and ‘Fan-Out’ WLP
  - Devices packaged using ‘Fan-Out’ WLP
  - Devices that can be found in both ‘Fan-Out’ WLP and ‘Flip Chip’
  - Devices packaged using ‘Flip-Chip’
  - Devices that can be found in WLP or ‘Flip-Chip’

- **Discrete passives**

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Smartphones are overall main end products for advanced packages

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LASTEST SMARTPHONES ON THE MARKET

Percentage of WLP packages in High End Smartphones is on the rise!

On average, 30% of the packages within high end smartphones are in WLP Packages.
Advanced Packaging Revenue forecast by packaging platform

- $B, account for of advanced packaging revenue in 2014

- Highest revenue CAGR expected from % and % respectively, as high volume products are entering the market

- Overall advanced packaging revenue CAGR estimated at %, rising from $B in 2014 to $B in 2020
Advanced Packaging wafer forecast
x1000 wspy 300 mm eq.

- 300 mm eq. wafers, account for ______ million of advanced packaging wafer count in 2014

- Highest wafer count CAGR expected from _______ and _______ with _____% and _____% respectively, as high volume products are entering the market

- Overall advanced packaging wafer count CAGR estimated at ______%, with wafer count rising from ______ to ______ million 300 mm eq. wafers from 2014 to 2020

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ADVANCED PACKAGING WAFER FORECAST 2014 vs. 2020

• Within Advanced Packaging, TSV based packages cover [ ]% of total advanced packaging wafers

• In 2014 [ ]% of Flip Chip package wafers contained TSVs, while [ ]% of FI WLP wafers contained TSVs

• Looking at the 2.5D / 3D platform, in 2014, [ ]% of TSV wafers were dedicated to FI WLP, [ ]% to Flip Chip packages and the remaining [ ]% were found in other package types

2014 Advanced Packaging WAFER SPLIT with 2.5D/3D

2014 2.5D/3D IC WAFER SPLIT
Advanced Packaging unit forecast by device categories (Mu)

• [redacted] take lead in unit count, with [redacted] billion units or [redacted]% of advanced packaging unit count in 2014

• Highest unit count CAGR expected from [redacted] and [redacted], [redacted]% and [redacted]% respectively, as high volume products are entering the market

• Overall advanced packaging unit count CAGR estimated at [redacted]%, with unit count rising from [redacted] billion to [redacted] billion units from 2014 to 2020
IC DEVICE TYPES BY ADVANCED PACKAGING PLATFORM 2014 vs. 2020

Analog and Mixed signal

2014 Analog and Mixed signal by Advanced Packaging platform

2020 Analog and Mixed signal by Advanced Packaging platform
IC DEVICE TYPES BY ADVANCED PACKAGING PLATFORM 2014 vs. 2020

CMOS image sensors

2014 CIS by Advanced Packaging platform

2020 CIS by Advanced Packaging platform
IC DEVICE TYPES BY ADVANCED PACKAGING PLATFORM 2014 vs. 2020

MEMS

2014 MEMS by Advanced Packaging platform

2020 MEMS by Advanced Packaging platform
Leftover capacity in 2014 and required capacity increase forecast
2014 SEMICONDUCTOR INDUSTRY REVENUE SPLIT

2014 Semiconductor Industry split by REVENUE

- $\Box$ companies lead semiconductor revenues with $\Box\%$ of the total when combined.
- $\Box$ providers follow with $\Box\%$ of the total revenue, respectively.
- $\Box$ companies account for $\Box\%$ of the total semiconductor revenue.

Total Cap Ex accounted for $\Box$B or $\Box\%$ of total semiconductor revenue.
2014 TOTAL OSAT MARKET SHARE

OSAT Market share by REVENUE (w/o IDMs and foundries)

- [Blank] accounts for [Blank]% of the OSAT market
- Top 4 OSATs (including latest STATS ChipPAC acquisition by JCET) cover [Blank]% of the OSAT market

NOTE: includes all package types

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2014 ADVANCED PACKAGING ASSEMBLY AND TEST WAFER SHARE
Including Foundries and IDM

- In 2014, the Advanced Packaging portion of assembly and test by wafer count is lead by
- % of assembly and test is outsourced and performed by OSATs and WLP houses

2014 Advanced Packaging WAFER share
(include IDMs and foundries)

2014 Advanced Packaging WAFER share
By business model
2014 ADVANCED PACKAGING ASSEMBLY AND TEST WAFER SHARE

Including Foundries and IDM

- Providing TSMC inFO is employed for the Apple A10 processor in 2016, with wafer starts of wafers per month and an average wafer count growth rate of

- With high volume TSMC inFO adoption, 2016 could bring a scenario where of the advanced packaging market by wafer count!

2014 Advanced Packaging WAFER share (including IDMs and foundries)  

2016 Advanced Packaging WAFER share (including IDMs and foundries)
2014 ADVANCED PACKAGING ASSEMBLY AND TEST WAFER SHARE

By company

Intel by Advanced Packaging platform

Samsung by Advanced Packaging platform

Texas Instruments by Advanced Packaging platform

2014 TSMC by Advanced Packaging platform

Possible TSMC scenario in 2016

2016 TSMC by Advanced Packaging platform

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2014 ADVANCED PACKAGING ASSEMBLY AND TEST WAFER SHARE

By company

ASE by Advanced Packaging platform

SPIL by Advanced Packaging platform

Amkor by Advanced Packaging platform

Nepes by Advanced Packaging platform

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Several semiconductor groups exhibit recognizable exceptions – representative leaders with higher revenue and/or margin.
FINANCIAL INSIGHT - SEMICONDUCTOR INDUSTRY
By R&D Expenses – W/ outliers

Semiconductor supply chain by R&D Expenses
FINANCIAL INSIGHT - SEMICONDUCTOR INDUSTRY

By Net income – W/ outliers

- More exceptions and some new names exhibit higher net income % from total revenue, distinguishing themselves from the base group.
OSAT by Gross Margin

- OSATs fall into the Gross margin group between
- distinguish themselves by
Future trends - production ranges per packaging platform (sweet spots)

- Foundry based packaging (WLP) andsubstrate based packaging (Flip Chip) are competing in the sub 10nm/10nm line width/pace and sub 0.4 mm pitch.
Usual production ranges per packaging platform (sweet spots)

- Fan-In WLP are the thinnest and smallest package limited only by the Si die in width and bump and Si die in height – current package size ranges up to ______ with expansion planned up to ______ and ______.

- Fan-Out WLP can essentially cover all Fan-In area and beyond where bumps do not fit under the surface of the Si die – as Fan-In, Fan-Out packages are increasing in size and will soon be expanding to size encapsulating application processors.

- In terms of thickness and area, ______ can essentially cover most of ______ area, while extending to larger packages up to ______.
PRODUCT ANNOUNCEMENTS

Non exhaustive list

More and more products announced in different segments!
Micro Pillar as well as flip chip bumps are used in the first GPU 3D stacked from AMD!
SAMSUNG GALAXY S6
Processor Package Teardown

Flip Chip solder bumping is used in the processor of the Samsung Galaxy S6

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FO WLP activity Revenues (M$)
Overall evolution since eWLB technology introduction
FOWLP wafer forecast (300mm eq. wafers)

*Breakdown by application area*
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Job Title:
Company:
Address:
City:
State:
Postcode/Zip:
Country*:
*VAT ID Number for EU members:
Tel:
Email:
Date:

PAYMENT
BY CREDIT CARD
☐ Visa ☐ Mastercard ☐ Amex
Name of the Card Holder:
Credit Card Number:
Card Verification Value (3 digits except AMEX: 4 digits):
Expiration date:

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F-69002 Lyon, France,
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Account No: 0170 200 1565 87,
SWIFT or BIC code: CCFRFRPP,
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The group supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

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6.4 In the context of an audit or any other inspection, the person contact shall decide who within the Buyer, shall be entitled to access on line the reports on -1 micronews.com. In this respect, the Seller will give the Buyer a maximum of 10 passwords, unless the multiple sites organization of the Buyer requires more passwords. The Seller reserves the right to check from time to time the correct use of this password.

6.5 In case of a misuse of any kind, the Buyer is prohibited from using the Products or to discontinue production.

6.6 In this context of an audit or any other inspection, the person contact shall decide who within the Buyer, shall be entitled to access on line the reports on -1 micronews.com. In this respect, the Seller will give the Buyer a maximum of 10 passwords, unless the multiple sites organization of the Buyer requires more passwords. The Seller reserves the right to check from time to time the correct use of this password.

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From Technologies to Markets
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- Compound Semi.
- LED
- Power Electronics
- Energy Conversion
- Advanced Packaging
- MedTech
- Manufacturing
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  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis

- **Reports**
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  - Teardowns & Reverse Costing Analysis
  - Cost Simulation Tool

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  - [www.systemplus.fr](http://www.systemplus.fr)

- **KnowMade**
  - IP analysis
  - Patent assessment
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Custom analysis scope is defined with you to meet your information and budget needs.
• Our analysts provide market analysis, technology evaluation, and business plan along the entire supply chain.
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• Our reports are unmatched in quality and technology depth and typically include:
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  - High End Gyro, Accelerometers and IMU
  - Non Volatile Memory Markets and Technology Trends

- **IMAGING & OPTOELECTRONICS**
  - Camera Module Packaging (Vol 1: Market & Technology Trends / Vol 2 Teardowns & Reverse Engineering)
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  - Status of the CMOS Image Sensors

- **MEDTECH**
  - Microfluidic for Sample Preparation
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  - Sapphire Applications & Market 2015: from LED to Consumer Electronics
  - Status of Wide Band Gap Material: GaN, SiC (and also AlN, Ga2O3, Diamond as a trend)
  - GaN and SiC Devices for Power Electronics Applications

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  - Status of Power Electronics Industry
  - Status of Wide Band Gap Material: GaN, SiC (and also AlN, Ga2O3, Diamond as a trend)
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  - Supply Chain Readiness for Panel Manufacturing in Packaging
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  - 2.5D & 3DIC Business Update*
  - Fan-Out and Embedded Die: Technologies & Market Trends

- **MANUFACTURING**
  - Photolithography Equipment and Materials for Advanced Packaging, MEMS and LED Applications
  - Thinning & Dicing Equipment for Advanced Packaging, MEMS, Photovoltaics, LED, CMOS Image Sensors
  - Non Volatile Memory Markets and Technology Trends

- **Reports to be decided within 2015**
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