Introduction

Analysts

Worldwide and Dedicated:

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Utilizing worldwide offices of SEMI in Europe, Korea, China, Taiwan, Singapore

Working with third parties such as in Japan
Outline

The Landscape
Fabs Increasing Capacity
Fabs Losing Capacity
Changes in Capacity: Analysis
Equipment Spending Trends
SEMI’s New Reports
Summary
Some high level forecasts are done to 2019

More detailed forecasts go to 2018

SEMI will publish an update of the 200mm Fab Outlook report to 2020 in 3Q16
200mm Fabs awaken!

From 2015 on
Increase of 200mm:
...Capacity
...Equipment spending
...Fab Count

New equipment being built

Increase for 200mm
Silicon Shipment Fcst

Installed Capacities 200mm Fabs

Source: Global 200mm Fab Outlook, preliminary July 2016, SEMI
The Landscape
The Landscape:
Fab Count by Wafer Size 1995 to 2018 for 150mm, 200mm, 300mm

- Count of Front end fabs in operation at the end of each year (excluding LED, EPI, BEOL, R&Ds, Backend).
- 150mm began in 1980 (Intel)
- Dawn of 200mm began in 1990 (IBM Fishkill pilot with Siemens 64Mbit DRAM)
- 300mm began in 2000 (SC300 with Siemens & Motorola). Beta lines in 1998 US (I300I), Japan (Selete)
The Landscape:  
200mm Fab Count (Volume Fabs)

- Count of Front end fabs in operation at the end of each year (excluding LED, EPI, BEOL, R&Ds, Backend).
- 200mm fab count increased from 70 fabs in 1995, peak of 200 fabs end of 2007, declined to 180 in 2015.
- With the 2008/2009 economic downturn, more 200mm fabs closed and/or transitioned to 300mm (with strongest impact from 2008 to 2010).
- Recent (2015 to 2016) Mergers & Acquisitions: most fabs are 200mm for Logic, Foundry, Analog/Mixed Signal and Power.

**Mergers & Acquisitions 2015 - 2016**

- Total fabs affected: 57
  - 300mm fabs: 9
  - 200mm fabs: 29 (51%)
  - 150mm fabs: 15
  - <150mm: 4

Immediate fab closures: 2 150mm

Source: Global 200mm Fab Outlook, preliminary July 2016, SEMI
The Landscape:
Fab Capacity by Wafer Size 1995 to 2019 for 150mm, 200mm, 300mm

- 200mm fab capacity surpassed 150mm capacity in 1998 and peaked in 2007
- In 2008 installed 300mm fab capacity (in 200mm equivalents) surpassed 200mm capacity
- 200mm capacity declined in 2008 to 2009 but has been increasing gradually; by 2018/2019 200mm capacity estimated to reach level close to 2006

Source: Global 200mm Fab Outlook, preliminary July 2016, SEMI
From 2008 to 2014, 33 fabs closed (and remain closed) plus 15 fabs converted to 300mm
Slowdown of 200mm fab closures expected from 2016 on
Of the 33 fabs closed from 2008 to 2014, Americas and Japan closed the most fabs: 14 fabs each in each country affecting mainly Logic/MPU, Memory, followed by foundries
About 10 facilities are expected to begin operation from 2015 to 2017 mainly for Power, Analog and MEMS
By 2019 200mm installed capacity will be back to close to levels of 2006
The Landscape
Change of Capacity: for near future to 2018

- Capacity and count exclude EPI, LED, R&Ds
- By 2018 installed capacity (~5.3 Million wspm )
- 2007 was peak for capacity with 5.6 Million wafers per month (not shown here)
- Annual Silicon shipment trends also peaked in 2006
- Lowest level of 200mm installed capacity was in 2009

2015 to 2018*
+274K wspm

Expansion of old/existing and upgrade 6 to 8-inch:
- 27
- 152K wspm

New** 200mm cleanrooms
- 19
- 242K wspm

Loss due to closures or wafer size changes
- 120K wspm

* 4Q15 to 4Q18, excluding LED (1 LED)
**"New" means fabs/lines built in 2010 or later, counting Eugene as new

Source: Global 200mm Fab Outlook, preliminary July 2016, SEMI

200mm Fab Trends & Outlook, July 2016. C.G. Dieseldorff & S. Nachnani. Copyright SEMI 2016
Increasing Capacity
17 Fabs & Lines are expected to begin operation in 2015 to 2019

<table>
<thead>
<tr>
<th>Starting</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Europe &amp; Mideast</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Korea</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SE Asia</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Source: 200mm Fab Outlook report, World Fab Forecast (preliminary July 2016, SEMI)

Starting operation, all probabilities. Excluding EPI, LED, small R&Ds
Chart shows only fabs which add capacity (excludes fabs with losses)
Count in each year of 200mm Fabs adding capacity (same fab may show up in 1 or more years)
“New” refers to fabs that began operation in 2010 and later. “Existing” refers to fabs that began operation before 2010.
A new fab is included in each year’s count if capacity is being added
For example: in 2013, there were 9 new fabs which added capacity and 22 existing fabs
Losing Capacity
Loosing Capacity
200mm Fabs Closed/Will be Closed Trend 1999 to 2017

- Excluding R&Ds. Showing fabs which are still closed or will be closed (does not include fabs re-opened)
- 76 fab closures from 1999 to 2018
- Most closures occurred during economic downturn or weakness
- Most Fab closures from 2008 to 2018 are for Americas (14), Japan (14), Europe/Mideast (5)
- 200mm fab closures are slowing down
Losing Capacity
200mm Fabs Migrating to 300mm Trend 2008 to 2016

- From 2008 to 2016 we count 15 facilities converted from 200mm to 300mm or adding some 300mm capability
- Some fabs closed but re-opened as 300mm later
- There is no known conversion from 200mm planned for 2017 forward at this time
- Foundry, Logic and Memory each have 4 fab conversions, MPU: 3
- **Not included but noteworthy:** two 200mm fabs changed to 4-inch (LED), Samsung Line 4 and Line 5

Source: 200mm Fab Outlook Report, World Fab Forecast (preliminary July 2016, SEMI)
### Losing Capacity

200mm Fabs Repurposed Non-Semiconductor 2008 to 2010

List of Known 200mm Fabs that have been re-purposed to non-microelectronics applications

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Fab</th>
<th>Built</th>
<th>Closed</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujitsu</td>
<td>Tanzawa, Japan</td>
<td>Building 2</td>
<td>1984</td>
<td>1997</td>
<td>Re-purposed into greenhouse</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>Aizu Wakamatsu, Japan</td>
<td>Building 2-1</td>
<td>1996</td>
<td>2010</td>
<td>Re-purposed into greenhouse</td>
</tr>
<tr>
<td>TI</td>
<td>Arlington, Texas</td>
<td>Arlington site (Fab 3)</td>
<td>1996</td>
<td>2010</td>
<td>An un-named buyer had plans to re-develop site for $30M starting June 2015 to end 2015 (possibly warehouse)</td>
</tr>
<tr>
<td>Western Digital</td>
<td>Phoenix, Arizona</td>
<td>Phoenix site</td>
<td>1995</td>
<td>2010</td>
<td>Former STMicro fab. Plan known as of mid 2015: Convert site into restaurants, retail, housing by Phoenix-based Evergreen Development</td>
</tr>
<tr>
<td>QTS (former Qimonda)</td>
<td>Richmond, Virginia</td>
<td>200mm</td>
<td>1998</td>
<td>2009</td>
<td>Re-purposed 200mm and 300mm fab to data center</td>
</tr>
<tr>
<td>Micron</td>
<td>Boise, Idaho</td>
<td>200mm</td>
<td>~1999</td>
<td>2009</td>
<td>Fab converted into a solar fab in 2010 by TRansform Solar a 50:50 JV between Micron and Origin</td>
</tr>
</tbody>
</table>

- This does not include the Maxim Facility in San Jose acquired by Apple
- Once a fab was closed it loses visibility
Changes in Capacity: Analysis
Changes in Capacity
Changes by Region 2015 to 2018

Capacity added from 4Q15 to 4Q18

Cap Changes By Region from 2015 to 2018

Source: 200mm Fab Outlook report, World Fab Forecast (preliminary July 2016, SEMI)

*Existing: all these fabs originally began operation before 2010
*New: all these fabs began operation in 2010 or after
In comparing 2006 versus 2018, memory capacity share of 200mm has declined to just about 2%. Most memory production has migrated to 300mm fabs.

A similar transition to 300mm has occurred with Logic/MPU production.

On the other hand, we see strong capacity growth from Discrete/Power, MEMS, and Analog segments in part to the transition from 150mm to 200mm.

Foundry has also been gaining share driven by strong demand for PMIC, Display driver IC, CMOS image sensor, MCU, MEMS, and other devices requiring >90nm process technology.
Equipment Spending Trends
Equipment Spending
Fab Equipment Spending by Wafer Size: 200mm and <200mm

- Front End Facilities, new, used, in-house, including LED, EPI
- Less spending for 2017 and 2018 may also be due to lack of visibility (data are still being gathered)
In 2017 spending for 200mm Front End facilities expected to be about US$2.3B

Decline of spending in 2017 for Foundries: some of known fabs completed equipping
Summary

200mm Fabs awaken!

Installed Capacities 200mm Fabs

From 2015 on
Increase of 200mm
...Capacity
...Equipment spending
...Fab Count

200mm equivalent wafers/month

<table>
<thead>
<tr>
<th>Year</th>
<th>200mm Fabs</th>
<th>2015</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>202 Fabs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>180 Fabs</td>
<td>-7%</td>
<td></td>
<td>+8%</td>
</tr>
<tr>
<td>2018</td>
<td>190 Fabs</td>
<td>+6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>191 Fabs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Global 200mm Fab Outlook, preliminary July 2016, SEMI
Update available 3Q 2016: Forecast to 2020
SEMI’s Fab report

SEMI presents a new report:

FABVIEW
ONLINE DATA AND FORECAST

Imagine:
Fab data at your fingertips:
any time and anywhere

✓ Fast access to fab information (mobile friendly), easy to use (no Excel)
✓ 3 years of data with forecast to next year
✓ Selection on top by: company, country/region, wafer size, product type, geometry, and status
✓ Immediate summaries on top by year for spending (equipment and construction) and capacity
✓ Fab details in grid below including fab type, start year, close year, fab comment, and changes made
Thank you