IC MARKET UPDATE AND CHINA IMPACT ANALYSIS

IMAPS Luncheon
Scottsdale, Arizona
February 16, 2017
Your Trusted Source for Semiconductor Market Research Analysis

**McCLean Report**
A Complete Analysis and Forecast of the Integrated Circuit Industry

**Integrated Circuit Market Drivers**
A Study of Emerging and Major End-Use Applications Fueling Demand for Integrated Circuits

**OSD Report**
A Market Analysis and Forecast for Optoelectronics, Sensors/Actuators, and Discretes

**Strategic Reviews**
Extensive Profiles of the World’s IC Manufacturers and Fabless IC Suppliers

**Global Wafer Capacity**
Detailed Analysis of Existing Wafer Capacity and a Complete Forecast

February 16, 2017
IMAPS Luncheon
Presentation Outline

• Global Economic and Cycle Trends

• Capital Spending Trends

• The Three Phases of China’s IC Industry Strategy
Global Economic and Cycle Trends
Electronic Industry Interdependence

2016 Worldwide GDP = $80.3 Trillion

**WW Electronic System Production**

- 2015: $1,423B, 2%
- 2016: $1,457B, 2%
- 2017F: $1,493B

**Semiconductor Market**

- 2015: $358.6B, 2%
- 2016: $364.9B, 5%
- 2017F: $384.7B

**Semi Cap Spending**

- 2015: $64.9B, 4%
- 2016: $67.7B, 5%
- 2017F: $71.3B

**Semi Materials Market**

- 2015: $45.7B, 3%
- 2016: $47.0B, 4%
- 2017F: $49.1B

Source: IC Insights
Capacity/Capital Spending Driven IC Industry Cycle Model 1958-2010

Source: IC Insights
## Worldwide GDP Breakdown (2015-2017F)

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>2015 GDP Growth %</th>
<th>2015 GDP ($ Trillions)</th>
<th>2015 (% of Total)</th>
<th>2016 GDP Growth %</th>
<th>2016 GDP ($ Trillions)</th>
<th>2016 (% of Total)</th>
<th>2017F GDP Growth %</th>
<th>2017F GDP ($ Trillions)</th>
<th>2017F (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Income Countries/Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>2.6%</td>
<td>17.39</td>
<td>22.2%</td>
<td>1.6%</td>
<td>17.67</td>
<td>22.0%</td>
<td>2.0%</td>
<td>18.02</td>
<td>21.9%</td>
</tr>
<tr>
<td>Eurozone</td>
<td>1.6%</td>
<td>12.46</td>
<td>15.9%</td>
<td>1.7%</td>
<td>12.67</td>
<td>15.8%</td>
<td>1.5%</td>
<td>12.86</td>
<td>15.6%</td>
</tr>
<tr>
<td>Japan</td>
<td>0.5%</td>
<td>6.07</td>
<td>7.7%</td>
<td>0.6%</td>
<td>6.11</td>
<td>7.6%</td>
<td>1.0%</td>
<td>6.17</td>
<td>7.5%</td>
</tr>
<tr>
<td>U.K.</td>
<td>2.2%</td>
<td>2.65</td>
<td>3.4%</td>
<td>2.0%</td>
<td>2.70</td>
<td>3.4%</td>
<td>1.1%</td>
<td>2.73</td>
<td>3.3%</td>
</tr>
<tr>
<td>Canada</td>
<td>0.9%</td>
<td>1.88</td>
<td>2.4%</td>
<td>1.3%</td>
<td>1.90</td>
<td>2.4%</td>
<td>2.1%</td>
<td>1.94</td>
<td>2.4%</td>
</tr>
<tr>
<td>Other</td>
<td>2.0%</td>
<td>11.86</td>
<td>15.1%</td>
<td>2.1%</td>
<td>12.11</td>
<td>15.1%</td>
<td>2.3%</td>
<td>12.39</td>
<td>15.0%</td>
</tr>
<tr>
<td><strong>Total High Income</strong></td>
<td>1.8%</td>
<td>52.31</td>
<td>66.8%</td>
<td>1.6%</td>
<td>53.16</td>
<td>66.2%</td>
<td>1.8%</td>
<td>54.12</td>
<td>65.7%</td>
</tr>
<tr>
<td><strong>Developing Countries</strong></td>
<td>3.7%</td>
<td>26.05</td>
<td>33.2%</td>
<td>4.1%</td>
<td>27.12</td>
<td>33.8%</td>
<td>4.2%</td>
<td>28.26</td>
<td>34.3%</td>
</tr>
<tr>
<td><strong>Worldwide Total</strong></td>
<td>2.4%</td>
<td>78.36</td>
<td>100.0%</td>
<td>2.5%</td>
<td>80.28</td>
<td>100.0%</td>
<td>2.6%</td>
<td>82.37</td>
<td>100.0%</td>
</tr>
<tr>
<td>China*</td>
<td>6.9%</td>
<td>10.18</td>
<td>13.0%</td>
<td>6.7%</td>
<td>10.86</td>
<td>13.5%</td>
<td>6.5%</td>
<td>11.57</td>
<td>14.0%</td>
</tr>
<tr>
<td>India*</td>
<td>7.5%</td>
<td>2.25</td>
<td>2.9%</td>
<td>7.3%</td>
<td>2.41</td>
<td>3.0%</td>
<td>6.8%</td>
<td>2.58</td>
<td>3.1%</td>
</tr>
<tr>
<td>Brazil*</td>
<td>-3.8%</td>
<td>2.26</td>
<td>2.9%</td>
<td>-3.3%</td>
<td>2.19</td>
<td>2.7%</td>
<td>0.5%</td>
<td>2.20</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

*Included in Developing Countries

Source: World Bank, IMF, IC Insights
Worldwide GDP and IC Market Growth Correlation Coefficient History and Forecast (1980-2021F)

Source: IC Insights
Value of Semiconductor M&A Agreements

2010-2014 = $62.9B

Source: IC Insights
Regional Breakdown of 2015-2016 M&A Wave

**Buyers**
- **U.S.** $104.5B (51.8%)
- **Japan** $37.0B (18.4%)
- **Asia-Pacific** $46.4B (23.0%)
- **China** $8.3B (4.1%)

**Acquisitions**
- **Europe** $77.9B (38.6%)
- **U.S.** $122.6B (60.8%)
- **Asia-Pacific** $1.1B (0.6%)

*One 2015 acquisition agreement in Japan was for a 300mm fab at $157 million, or < 0.1% of the total.

Source: IC Insights

Source: IC Insights
2011-2017F IC Market Growth versus Worldwide GDP Growth

Source: IC Insights
Capital Spending Trends
Worldwide Semiconductor Capital Spending Trends
(2000-2021F)

Source: IC Insights
Semiconductor Capital Spending as a Percent of Semiconductor Sales

- Capital Spending % of Semi Sales
- Capital Spending Change

Source: IC Insights
Semiconductor Capital Expenditures by Headquarters Location

Source: IC Insights
Top 5 Share of Total Semiconductor Capital Spending

Source: IC Insights
Worldwide IC Wafer Capacity Changes (200mm Equivalents)

94-10 9.0% CAGR
10-16 5.3% CAGR

Source: SIA, IC Insights
2003-2017F Quarterly IC Unit Volume Shipment Trend

Source: WSTS, IC Insights
The Three Phases of China’s IC Industry Strategy
Japan and China's Shares of the Total IC Market

Source: IC Insights
China IC Market vs. China IC Production Trends

IC Production Share of China IC Market:
- 2011: 9.8%
- 2016: 11.6%
- 2021F: 17.9%

Source: IC Insights
## Major IC Manufacturers in China

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>2010 Sales ($M)</th>
<th>2011 Sales ($M)</th>
<th>2012 Sales ($M)</th>
<th>2013 Sales ($M)</th>
<th>2014 Sales ($M)</th>
<th>2015 Sales ($M)</th>
<th>2016 Sales ($M)</th>
<th>Products</th>
<th>2021 Sales ($M, Fcst)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SK Hynix*</td>
<td>2,040</td>
<td>2,450</td>
<td>2,360</td>
<td>3,200</td>
<td>4,040</td>
<td>4,100</td>
<td>3,680</td>
<td>DRAM</td>
<td>5,500</td>
</tr>
<tr>
<td>2</td>
<td>SMIC**</td>
<td>1,555</td>
<td>1,320</td>
<td>1,542</td>
<td>1,962</td>
<td>1,970</td>
<td>2,236</td>
<td>2,921</td>
<td>Foundry</td>
<td>5,100</td>
</tr>
<tr>
<td>3</td>
<td>Samsung*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>270</td>
<td>2,370</td>
<td>2,725</td>
<td>3D NAND Flash</td>
<td>6,100</td>
</tr>
<tr>
<td>4</td>
<td>Hua Hong Semi</td>
<td>0</td>
<td>0</td>
<td>571</td>
<td>585</td>
<td>665</td>
<td>650</td>
<td>712</td>
<td>Foundry</td>
<td>1,000</td>
</tr>
<tr>
<td>5</td>
<td>TSMC*</td>
<td>263</td>
<td>366</td>
<td>470</td>
<td>510</td>
<td>550</td>
<td>590</td>
<td>635</td>
<td>Foundry</td>
<td>1,500</td>
</tr>
<tr>
<td>6</td>
<td>Intel*</td>
<td>30</td>
<td>1,865</td>
<td>2,380</td>
<td>2,650</td>
<td>2,710</td>
<td>1,830</td>
<td>520</td>
<td>3D NAND Flash</td>
<td>2,700</td>
</tr>
<tr>
<td>7</td>
<td>Shanghai Huali</td>
<td>0</td>
<td>0</td>
<td>70</td>
<td>210</td>
<td>295</td>
<td>370</td>
<td>460</td>
<td>Foundry</td>
<td>1,100</td>
</tr>
<tr>
<td>8</td>
<td>CR Micro</td>
<td>259</td>
<td>213</td>
<td>179</td>
<td>165</td>
<td>180</td>
<td>190</td>
<td>205</td>
<td>Foundry/Std ICs</td>
<td>290</td>
</tr>
<tr>
<td>9</td>
<td>Diodes-BCD</td>
<td>119</td>
<td>125</td>
<td>139</td>
<td>155</td>
<td>170</td>
<td>180</td>
<td>200</td>
<td>Foundry/Std ICs</td>
<td>275</td>
</tr>
<tr>
<td>10</td>
<td>XMC</td>
<td>0</td>
<td>0</td>
<td>160</td>
<td>150</td>
<td>165</td>
<td>175</td>
<td>195</td>
<td>Foundry/3D NAND</td>
<td>1,300</td>
</tr>
<tr>
<td>11</td>
<td>ASMC</td>
<td>145</td>
<td>147</td>
<td>135</td>
<td>117</td>
<td>130</td>
<td>119</td>
<td>115</td>
<td>Foundry</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>HeJian***</td>
<td>223</td>
<td>208</td>
<td>215</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Foundry</td>
<td>0</td>
</tr>
<tr>
<td>—</td>
<td>Others</td>
<td>1,211</td>
<td>1,211</td>
<td>590</td>
<td>575</td>
<td>590</td>
<td>605</td>
<td>625</td>
<td>—</td>
<td>4,700</td>
</tr>
<tr>
<td></td>
<td><strong>Total Chinese IC Production</strong></td>
<td>$5,845</td>
<td>$7,905</td>
<td>$8,811</td>
<td>$10,279</td>
<td>$11,735</td>
<td>$13,415</td>
<td>$12,993</td>
<td>—</td>
<td>$29,705</td>
</tr>
<tr>
<td></td>
<td><strong>WW IC Market ($B)</strong></td>
<td>$267.8</td>
<td>$270.3</td>
<td>$259.3</td>
<td>$271.9</td>
<td>$296.6</td>
<td>$292.0</td>
<td>$297.8</td>
<td>—</td>
<td>$378.4</td>
</tr>
<tr>
<td></td>
<td>Chinese Companies' Share of WW IC Market</td>
<td>2.18%</td>
<td>2.92%</td>
<td>3.40%</td>
<td>3.78%</td>
<td>3.96%</td>
<td>4.59%</td>
<td>4.36%</td>
<td>—</td>
<td>7.85%</td>
</tr>
</tbody>
</table>

*China fab production only.
**Partially owned by TSMC and includes Xinxin (now XMC) sales. XMC's sales listed separately from SMIC starting in 2012.
***Merged with UMC beginning in 2013.

Source: IC Insights' Strategic Reviews database, CCID, CSIA, PwC
## The Three Phases of China's IC Industry Strategy

<table>
<thead>
<tr>
<th>Phase</th>
<th>Approach</th>
<th>Timeframe Initiated</th>
<th>Successful?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Build a strong indigenous pure-play foundry industry</td>
<td>Late 1990s - Early 2000s</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Build a strong presence in the fabless IC supplier space</td>
<td>Early 2000s - Mid 2000s</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Build a strong China-based IC supplier/manufacturer base with startups, acquisitions, and mergers</td>
<td>Mid 2010s - Late 2010s</td>
<td>????</td>
</tr>
</tbody>
</table>

Source: IC Insights
Chinese Companies' Share of the Pure-Play Foundry Market

Source: IC Insights
2016 Fabless Company IC Sales by Company Headquarters Location ($88.9B)

- **U.S. Companies**: 53%
- **Taiwanese Companies**: 18%
- **Chinese Companies****: 10%
- **European Companies**: 2%
- **Japanese Companies**: <1%
- **Japanese Companies**: 17%
- **Other Companies***: 17%

**Source**: IC Insights

*Singapore-headquartered Broadcom Ltd's share is 16%

**6% excluding internal transfers of HiSilicon (Huawei), ZTE, and Datang

**2010**
- U.S. 69%
- Taiwan 17%
- China 5%
- Europe 4%
- Japan 1%
- Other 4%
# Outline of China's Semiconductor Industry Investment Funds

<table>
<thead>
<tr>
<th>Investment Fund</th>
<th>Amount of Money</th>
<th>Purpose</th>
<th>Managers of the Fund</th>
</tr>
</thead>
</table>
| China's Government Funds for National IC Industry Support | 120 billion RMB ($19.5B) between 2014-2017 | 1. National level support and funding  
2. Support target IC enterprises  
3. Facilitate IC industry consolidation and enhance the competitiveness of the leading IC enterprises  
4. Allocation of funds: Wafer manufacturing (40%)  
Chip design (30%)  
Chip packaging and testing (30%) | —China Development Bank |
| Local Government and Private Equity Investments in China | 600 billion RMB ($97.4B) | This pacesetting fund is to promote resource integration and M&A through investment in key enterprises, projects and innovative entities or platforms. | —Beijing IC Industry Equity Investment Fund ($4.9B)  
— Other Chinese Provinces, like Wuhan, Shanghai, Shenzhen, are following the Beijing fund model and building up the local fund to support the IC industry.  
— Government's fiscal funds as a lead to attract more private equity investment in China. |

Source: EE Times  
6.16 RMB = $1.00
Announced Indigenous Chinese Company IC Fabs

- **XMC/Yangtze River Storage Technology** — Broke ground in 1Q16 for a 300mm 3D NAND flash fab that is due on-line in late 2017 or early 2018. Developing 32-layer technology with Spansion/Cypress (which has primarily been a NOR flash supplier).

- **Sino King Technology** — Former head of Japan-based Elpida intended to form a group to develop DRAM technology and construct a DRAM fab in China using Chinese investment money. The deal has reportedly fallen through.

- **Fujian Jin Hua Integrated Circuit Co.** — Intends to construct a DRAM fab that will begin production in 3Q18 using 32nm technology developed with pure-play foundry UMC.

- **Shanghai Huali (HLMC)** — Secured $5.9B in funding to construct its second 300mm fab for foundry operations. The fab is due on-line in 3Q18 using 28nm technology. Will compete with TSMC, UMC, GlobalFoundries, and SMIC's China-based 300mm foundry fabs.

- **Tsinghua Unigroup Ltd.** — Reportedly intends to build a $30B wafer fab campus in Nanjing, China to produce DRAM and 3D NAND devices. The timetable and technology to be used were not mentioned.

Source: IC Insights
Issues Regarding China's Semiconductor Industry Initiatives (Part 1)

- **"Made in China 2025" Initiative** — Seeks to boost China's self-sufficiency rate in semiconductors from <20% in 2015 to 40% in 2020 and 70% in 2025. (Anything less than 100% is not self-sufficient)

- **ZTE Situation** — The semiconductor trade embargo placed on ZTE by the U.S. government, for allegedly shipping systems to Iran, has increased China's resolve to become more self-sufficient in semiconductors. (Embargo on hold through Feb. 2017)

- **No Apparent Cohesive Strategy** — China's Phase 3 company acquisitions and targets appear to be following a "shotgun" approach.

- **U.S. and China History of Espionage** — Given the mutual distrust, there is very little chance that the U.S. government will allow future acquisitions of U.S.-based semiconductor companies by Chinese entities. Tsinghua's offer for Micron was a "wakeup call" to U.S. government agencies. The 1Q17 report by the U.S government made its opinion on this topic public.

Source: IC Insights
• **Taiwan "Pushback"** — In June of 2016, Morris Chang, Chairman of TSMC, said that in order to protect intellectual property, Chinese companies should not get board seats in Taiwanese companies in which they invest. Chinese offers to purchase 25% shares of Taiwan-based OSAT suppliers Powertech, ChipMOS, and SPIL all fell through from lack of support from the Taiwan government.

• **Opportunity Fades** — With many governments on "high alert" with regard to China's semiconductor industry ambitions, the 'window of opportunity' for major acquisitions has closed.

• **Legal Issues Loom** — IC Insights believes it will be almost impossible to develop new DRAM and 3D NAND flash technology without infringing on numerous patents. Chinese companies also must be careful about hiring employees away from existing IC producers in China (ref. the 2003-2005 TSMC/SMIC situation).

• **Money isn't Everything** — All of the newly announced IC fabs to be constructed by indigenous Chinese companies will be at least one generation behind the leading technology when they come online. Massive investment to have no significant impact on leading-edge IC technology for many years. Without technology, China's IC industry results are likely to fall short of its goals.

Source: IC Insights
China-based Share of Total China IC Market

Source: IC Insights
Thank you for your attention!

Additional information

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