

**Semiconductor Speaker Series Luncheon**

# *Semiconductor Manufacturing Strategy: Where in the world to locate a fab or cleanroom?*

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Founder, President & CEO

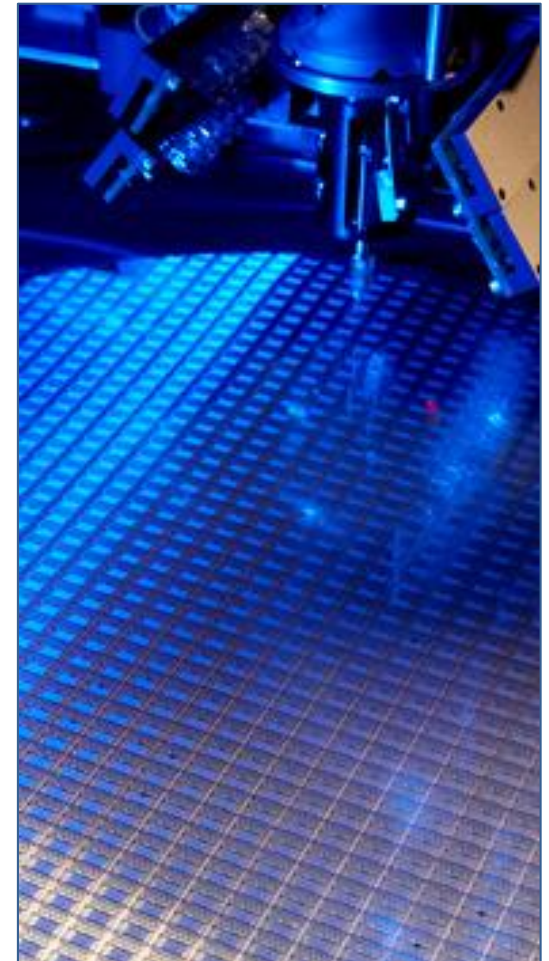


August 21, 2019  
Milpitas, CA

# Today's Agenda

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- **Global Semiconductor Market Overview**
- **Manufacturing Strategy – Internal Factors**
- **Manufacturing Strategy – External Factors**
- **Spotlight on China**
- **Spotlight on Automotive**
- **Key Takeaways**
- **Q&A**



# Global Semiconductor Market Overview – 2018 / 2019

## Continuous M&A activity and consolidation

- 76 transactions (\$35,879 million) in 2017\*
- 32 transactions (\$48,244 million) in 2018\*
- 24 transactions (\$25,236 million) in 2019 YTD\*
- Increasing number of blocked deals due to regulatory reviews by governments in Europe, China, and the USA (e.g. Qualcomm-NXP deal)



## 2018 slowdown + 2019 increase in operational fab sales

- No operational fab closed in 2018. This is the first time this has happened since ATREG began tracking operational fab sales in 2001. Despite this, ATREG saw a resurgence in interest in used operational fabs in the second half of 2018 which will lead to multiple sales closing in 2019

## Lack of 200mm capacity and 200mm used tools

- Driving renewed interest in operational 200mm fabs
- Values of 200mm tools and operational 200mm fabs spiking as a result of market constraints

## Economic development entities making a push for greenfield 300mm fabs

- Multiple groups are pursuing 300mm greenfield fabs and offering substantial incentive packages

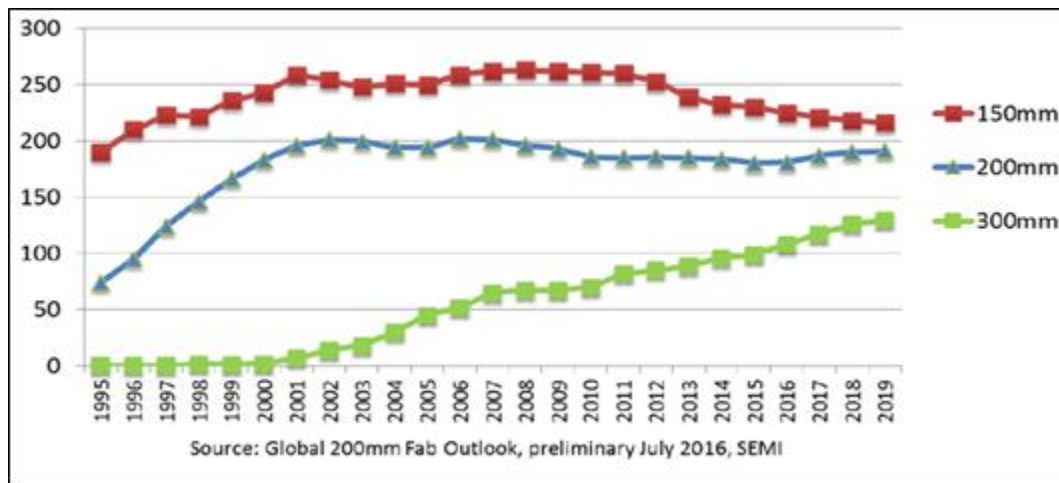
## Market uncertainty making western manufacturing attractive again

- U.S. and European manufacturing seeing resurgence

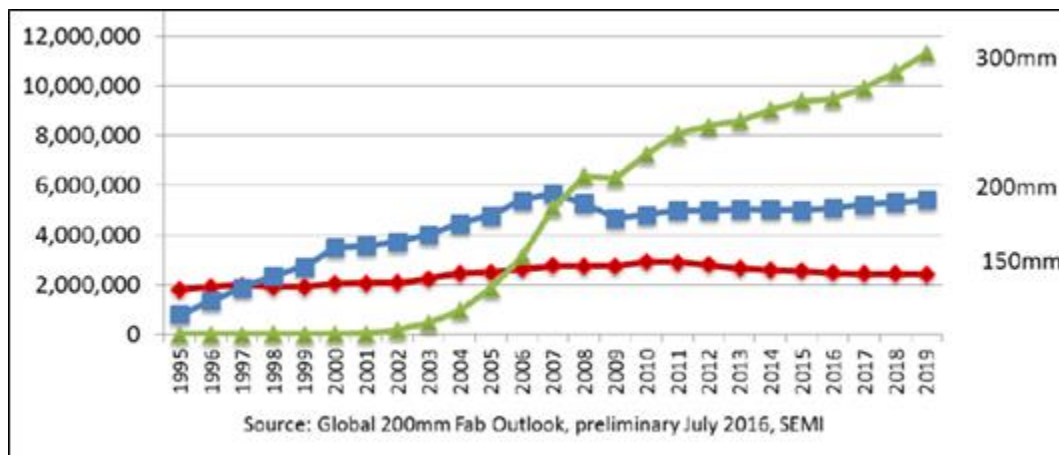
*\*(Source: Thomson One Banker, includes announced and closed transactions)*

# Global Semiconductor Market Overview – Fabs

## Number of fabs in operation at the end of each year



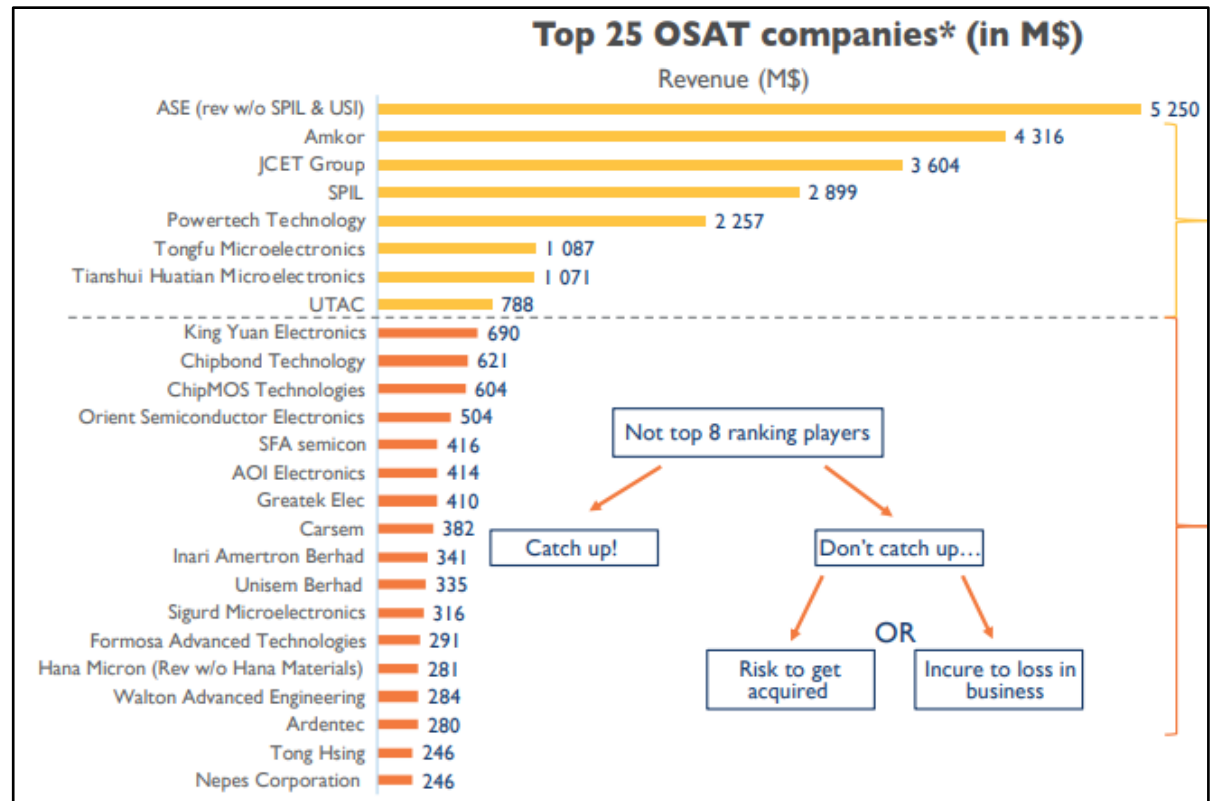
## Fab capacity (200mm equivalent) by wafer size



- **300mm** – Fueled mainly by foundry and memory growth, 49% of new fab projects in 2019 and 2020 will be for 300mm
- **200mm** – Demand continues to increase and this geometry is expected to account for 30% of new fab projects in 2019 and 2020
- **150mm** – The number of 150mm fabs is in steady decline and will eventually be outnumbered by 200mm fabs
- 300mm capacity (200mm equiv.) surpassed 200mm capacity in 2008
- Since bottoming out in 2009, 200mm capacity has been increasing gradually
- From 2019 to 2022, wafer shipments for MEMS and sensors devices are expected to increase 25% while shipments for power devices and foundries are forecast to jump 23% and 18%, respectively

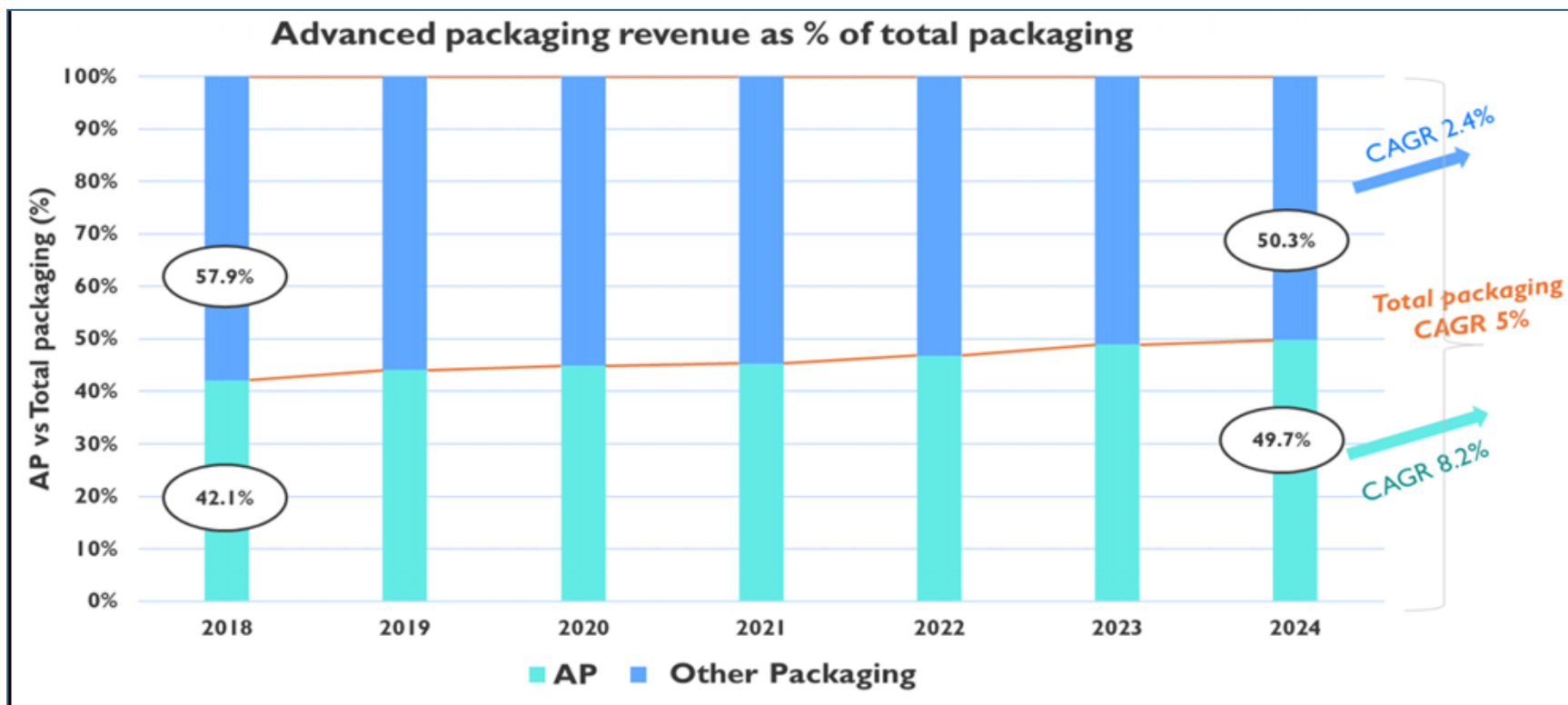
# Who Controls The OSAT Market?

- Annual revenue among top 25 OSATs amounted to \$27.9 billion in 2018
- 65% of the A&T market is controlled by three Asia-based companies: Amkor, ASE, and JCET
- Top eight OSATs (33%) account for \$21.2 billion or 76% of revenue
- Companies outside of the top 8 risk being an acquisition target if they cannot grow revenues beyond current levels



Source: Yole Développement, 2019

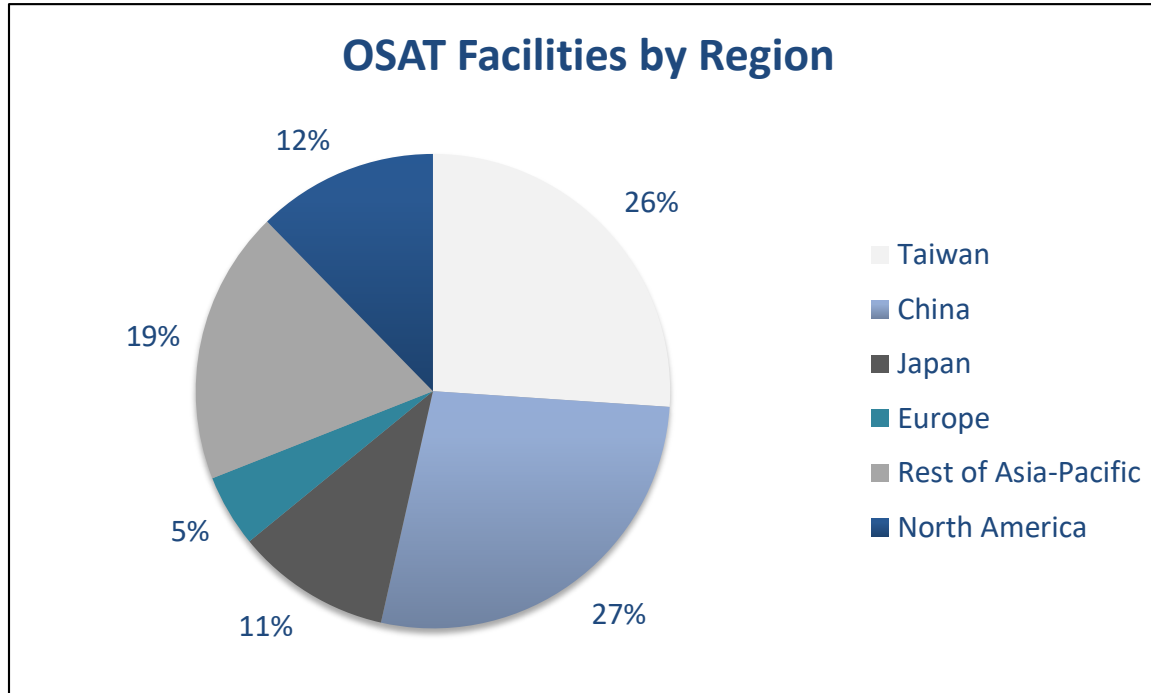
# Global Semi Market Overview – Advanced Packaging



Source: Yole Développement, 2019

- Advanced packaging will account for effectively half of total packaging by 2024
- CAGR for advanced packaging is three times higher than other packaging
- Advanced packaging revenue is expected to increase by 43% by 2024

# Where Are All The OSAT Fabs?

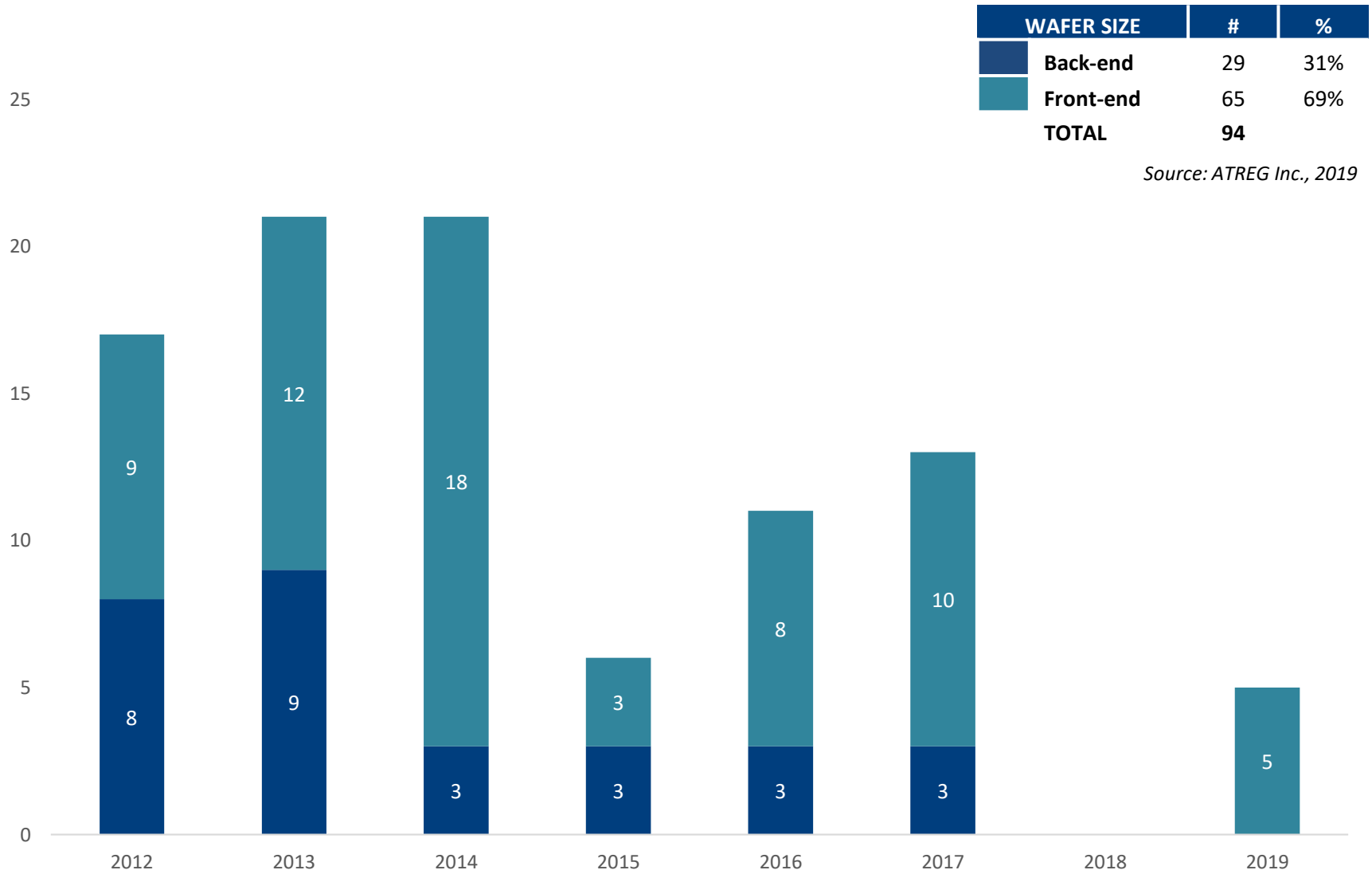


Source: SEMI Worldwide OSAT Manufacturing Database, Oct. 2017

- More than 80% of OSAT facilities are located in Asia
- More than 50% of OSAT facilities are located in either China or Taiwan
- The remainder of the Asia-Pacific region makes up a significant portion of OSAT facilities

Source: The Conference Board, 2016

# Fab Transactions Over The Last 8 Years (By Facility Type)



WAFER SIZE	#	%
Back-end	29	31%
Front-end	65	69%
<b>TOTAL</b>	<b>94</b>	

Source: ATREG Inc., 2019



# Fab Transactions Over The Last 8 Years

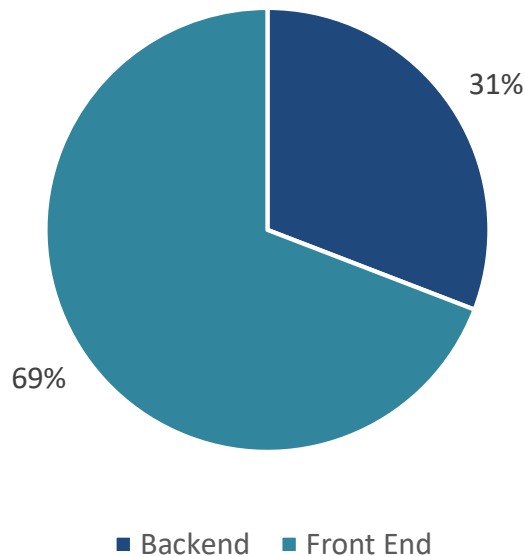
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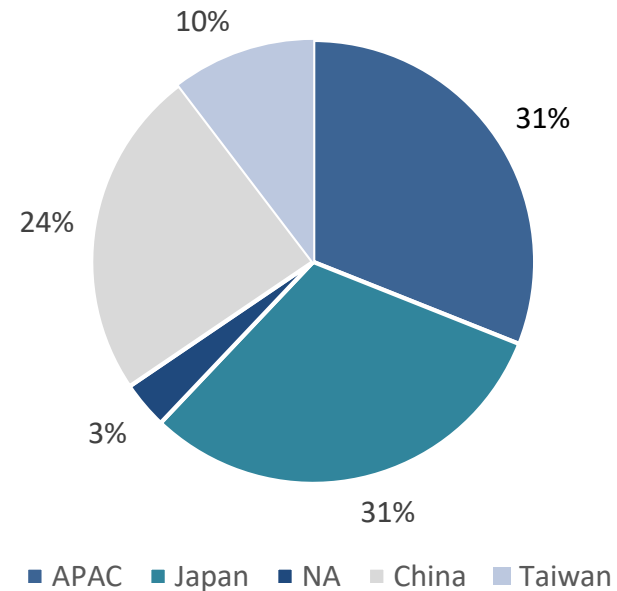
REGION	#	%
Asia-Pacific	9	31%
China	7	24%
Japan	9	31%
North America	1	3%
Taiwan	3	10%
<b>TOTAL</b>	<b>29</b>	

Source: ATREG Inc., 2019

## By Facility Type



## Back-End Fabs By Region



# Manufacturing Strategy – Internal Factors

## The financial investment consideration?

- For greenfield, building capex is hard to justify on the financials, thus incentives are a critical factor
- Securing used tools over new ones will reduce the capex needed to start a fab
- Finding a complete and integrated used tool line that can be moved from an existing fab into a new fab is difficult and these types of opportunities have dried up as the market has tightened, especially on 200mm
- Companies looking for a used and complete tool line must consider purchasing a fab operationally and operating it in place for a period of time before the relocation of the tool set could be considered



# Manufacturing Strategy – Internal Factors *(cont'd)*

## Existing loading & supply agreements are crucial

- Ensuring continuity in manufacturing capacity is of utmost importance, and this is where supply agreements and gradual transitions come in
- The ability for a buyer to neutralize operating costs as they introduce and qualify their own processes is a key component to most operational fab transactions
- Recent transaction examples:

April 2019




Acquisition of operational  
300mm fab from



East Fishkill, USA

February 2019



Disposition of operational  
200mm fab to



Greenock, UK

January 2019



Acquisition of operational  
200mm fab from



Tampines, Singapore

August 2017



Disposition of operational  
back-end facility to



Akita, Japan

# Manufacturing Strategy – External Factors

## Global competition & industry consolidation

- To cope with rising chip development costs, many semiconductor companies are turning to consolidation
- In 2018, the 10 largest companies combined for \$193.6 billion of sales, or more than 40% of the total market
- The top 25 companies are projected to grow around 16% and hold an 80% market share in 2018
- The rest of the market is estimated to grow by 3.6% in 2018. Samsung and Intel together made three out of every 10 dollars in the industry

2018 Rank	2017 Rank	Vendor	2018 Revenue (Billions of \$)	2018 Market Share (%)	2017 Revenue (Billions of \$)	2017-2018 Growth (%)
1	1	Samsung Electronics	75,854	15.9	59,875	26.7
2	2	Intel	65,862	13.8	58,725	12.2
3	3	SK hynix	36,433	7.6	26,370	38.2
4	4	Micron Technology	30,641	6.4	22,895	33.8
5	6	Broadcom	16,544	3.5	15,405	7.4
6	5	Qualcomm	15,380	3.2	16,099	-4.5
7	7	Texas Instruments	14,767	3.1	13,506	9.3
9	9	Western Digital	9,321	2.0	9,159	1.8
9	11	ST Microelectronics	9,276	1.9	8,031	15.5
10	10	NXP Semiconductors	9,010	1.9	8,750	3.0
		<b>Others</b>	<b>193,605</b>	<b>40.7</b>	<b>181,578</b>	<b>6.6</b>
		<b>Total Market</b>	<b>476,693</b>	<b>100.0</b>	<b>420,393</b>	<b>13.4</b>

Source: Gartner, 2018

# Manufacturing Strategy – External Factors *(cont'd)*

## Trade wars & tariffs

- Technology transfers to Huawei and its alliances restricted to protect national security
- May 20: U.S. imposes 25% tariffs on \$200 billion worth of Chinese imports
- June 1: In retaliation, China brought into effect its 10% to 25% tariff on \$60 billion worth of U.S. imports
- August 1: U.S. declares it will impose 10% tariffs on \$300 billion additional Chinese goods
- August 13: U.S. President delays tariff implementation, stock prices improved dramatically
- The U.S.-China trade war has spurred a 1,360% jump in investment in Malaysia:
  - Foreign direct investments into Penang state's manufacturing sector surged to \$2 billion in the first quarter from a year ago, more than for the whole of 2018
  - The state of Penang that is already home to Intel and Dell makes up 42% of Malaysia's manufacturing FDI
  - Micron invested RM1.5 billion over the past five years to open a new solid-state drive A&T center on a 52-acre plot of land that is expected to create about 1,000 local jobs
  - Jabil purchased 20 acres of land to expand its facility



# Manufacturing Strategy – External Factors *(cont'd)*

## IP protection

- Heated U.S.-China IP war with multiple lawsuits (Micron, Samsung, SK Hynix)

## Local supply chain

- Make sure the fab location you select offers an established semiconductor supply chain (e.g. despite attractive incentives, India is lacking)

## Talent availability & recruitment

- A fab site selection is only as successful as the pool of local talent it sources from. Choose a region that provides the highly educated workforce your manufacturing operations need now and in the future
- Engineering talent is not available everywhere, e.g. China



# Local Incentives – U.S. States

Many U.S. states offer tax exemptions, grants, and programs to incentivize companies to build fabs there, boost their advanced manufacturing industry, and create jobs.

## New York

- \$1.4 billion (\$655 million cash grant) funding to GF in 2006

## Texas Enterprise Fund

- Previously awarded to semiconductor companies (Sematech, Texas Instruments, Maxim Integrated Products, Samsung)

## Enterprise Florida

- Multiple incentive grants for advanced manufacturing, including sales and use tax exemption in semiconductor transactions involving manufacturing equipment (electricity, labor and machinery components of R&D, equipment repair)

## Wisconsin

- \$3 billion funding to Foxconn (refundable tax credits and sales tax exemption for construction materials)

## Oregon

- Multi-billion-dollar Intel CapEx, large tax exemptions

## Arizona

- Sales tax exemptions for manufacturing machinery / tools



# Local Incentives – Foreign

Governments around the world have funded or created new programs to recruit manufacturing companies to build in their country and stay competitive internationally.

## Singapore

- Offers tax exemption for companies looking to grow in Singapore in various investment categories (R&D, capability development, expansion)

## Korea

- 1.5 trillion to fund the development of new semiconductor materials or devices

## China

- China Integrated Circuit Industry Investment Co. Fund and Tsinghua Unigroup Fund, both funded at \$47 billion each

## Israel

- \$700 million funding to Intel for the Kiryat Gat fab and an additional \$200 million for upgrades in 2010

## European Union

- Important Projects of Common European Interest (IPCEI) status allows up to 20% of total investment to be covered with state money, which promotes large, strategic transnational projects

## Germany

- Saxony has provided subsidies for semiconductor companies such as Infineon and Siltronic AG for expansion in Dresden





# Spotlight on China

- More than 100 companies compete in China's packaging and assembly market, including leading multinational companies and emerging domestic players
- More than half of China's packaging companies are located in the Yangzi delta region, while midwestern China has emerged as a hotbed for packaging plants
- More than \$21.5 billion accumulated by the National IC Fund has spurred rapid gains throughout the region's IC supply chain

## Players having advanced packaging capability in China\*

(Source: Status & Prospects for the Advanced Packaging Industry in China report, Yole Développement, June 2016)



- Semiconductors are the largest import by revenue. With Phase 1 of IC Fund investment complete, Phase 2 of funding aims to raise another \$23 to \$30 billion
- IC design remains the largest semiconductor sector for the 2<sup>nd</sup> year in a row with \$31.9 billion in revenue, widening its lead over the IC packaging and test sector

# Spotlight on China *(cont'd)*

- China is struggling to complete all of its fab builds (at least eight facilities out of 30 are not yet built)
- New trend: Advanced technology companies are coming to the realization they should keep their fabs home and starting to pull out of China



- TI extending its existing 300mm fab in Richardson, TX
- Infineon investing €1.6 billion in a new 300-millimeter chip factory in Graz, Austria
- Bosch deciding to keep their investments in Dresden, Germany for a new 300mm fab
- STMicro announcing an expansion of existing sites in Europe
- Apple exploring moving 15 to 30% of its hardware production out of China

# Spotlight on Automotive

## Electronic megatrends: 2021 market values

(Source: Status of the Advanced Packaging Industry report, Yole Développement, 2018)



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- Automotive is by far the most prominent application for test and packaging. Smart automotive will represent a market value of \$1,630 billion by 2021 (about 100 million vehicles) (Yole Développement)
- Automotive is one of the key forces driving the growth in demand for semiconductor products with \$38 billion (Stratfor)

# Key Takeaways For A Successful Fab Site Selection

In this unstable global context, a fab site selection is a crucial part of a sound manufacturing strategy. Complete extensive global research to ensure your fab specifications are fully met.

- **Gain corporate alignment** between managers, executives, and the company board. Agree on a sound product strategy early on to ensure a viable business.
- **Carefully weigh the pros and cons of greenfield vs. brownfield.** Despite large amounts of incentives currently available to attract new fab construction, a sound, existing operational fab may be a better choice for your company in the long run and could ensure faster time-to-market.
- When considering a used fab, **don't get too hung up on the purchase price.** Evaluate the opportunity cost, know all assumed liabilities, and understand all operating expenses. **Negotiate a fair supply agreement** for both parties to ensure continuity of supply.
- **Don't underestimate your fab's local culture.** Understand it well to get the most out of your local workforce.













# Meet ATREG

- The only firm in the world specializing exclusively in the acquisitions and dispositions of global infrastructure-rich manufacturing assets
- 20 years of extensive transaction experience and deep market knowledge
- Global reach with advanced technology companies and long-standing relationships with key industry executives
- Our value-add is to maximize our clients' negotiating leverage by driving increased demand, creating pricing tension among buyers, and delivering the fastest, most optimal outcome (one year on market on average with ATREG vs. up to 4.5 years without ATREG)
- By completing disposition engagements in a more rapid timeframe, ATREG saves its clients millions of dollars in associated carrying costs



# Most Recent ATREG Transactions

CLIENT	TYPE	LOCATION	DESCRIPTION
 ON Semiconductor	300mm operational fab acquisition	East Fishkill, USA	Accelerates transition from 200mm to 300mm. Fab acquired from GF for \$430 million (over 3 years). Supply agreement till end 2022
 TEXAS INSTRUMENTS	200mm operational fab disposition	Greenock, UK	Advised TI in the sale of its operational 200mm Scottish fab to Diodes. Definitive agreement signed in Feb. 2019
 VIS	200mm operational fab disposition	Tampines, Singapore	Advised VIS in the purchase of GF's operational 200mm Fab 3E in SG for \$236 million. Definitive agreement signed in Jan. 2019
 GLOBAL FOUNDRIES	Tool sale	Singapore, Taiwan, Germany, USA	Advised GF in their worldwide tool sale to companies including TI, Micron, and UMC
 Micron	Operational back-end facility disposition	Akita, Japan	Advised Micron in the sale of its Akita facility to PTI. Definitive agreement signed in Jan. 2017 and transaction closed in Aug. 2017
 CYPRESS EMBEDDED IN TOMORROW	200mm operational fab disposition	Bloomington, USA	Advised Cypress in the sale of its Minn. fab to SkyWater. Definitive agreement signed in Nov. 2016 and transaction closed in March 2017
 QUALCOMM	150mm cleanroom facility disposition	San Jose, USA	Advised Qualcomm MEMS Technologies in its display fab sale. Definitive agreement signed in July 2016 and transaction closed in Oct. 2016
 RENESAS	200mm operational fab disposition	Shiga, Japan	Advised Renesas on the sale of its Shiga fab to ROHM. Definite agreement signed in April 2015 and transaction closed in Feb. 2016
 maxim integrated.	200mm fab disposition	San Jose, USA	Advised Maxim on the sale of its 200mm San Jose fab to Apple. Definitive agreement signed and transaction closed in Dec. 2015
 QUALCOMM	Cleanroom facility disposition	Longtan, Taiwan	Advised Qualcomm MEMS Technologies on this sale to TSMC for advanced packaging production. Definitive agreement signed in Oct. 2014 and transaction closed in April 2015



**Thank you for your attention!**

**Q&A**

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