FOCUS ON CHINA
China’s semiconductor industry rises as a global challenger
China’s semiconductor industry rises as a global challenger

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Semiconductor Industry 2022
Quick snapshot
2022 SEMICONDUCTOR DEVICE INDUSTRY REVENUE (IN $B)

2022 Semiconductor device players
per geographical area (in %)

US  KR  JP  TW  EU  CN

2021
$555B
2022
$573B

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SEMICONDUCTOR MARKET SHARE PER GEOGRAPHICAL AREA (IN %)

By business model type

2022 Semiconductor market share per geographical area (in %)

*Added Value only: Revenue minus cost of bought-in material & components
SiC: Are we seeing the Chinese companies catching up?
POWER SiC INDUSTRY - PERFORMANCE SCORECARD

Source: Power SiC 2023 - Yole Intelligence

Market value & growth – US$

1.1B

+62%

1.8B

SiC wafer shipment 6”-eq. units

364,874 576,300

Top 3 SiC power device market shares*

STMicroelectronics

37% (US$450M)

32% (US$700M)

Infineon

20% (US$242M)

17% (US$360M)

Wolfspeed

14% (US$165M)

14% (US$299M)

*In revenue

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Who are the companies capturing the SiC market in the past 2 years?

At SiC device and wafer levels

The SiC device market is mainly controlled by leading IDMs, up to 86% by the top 6 players. And they are adding significant capacity globally scope to ensure leadership in the coming years.

New entrants have gained a significant share in the SiC wafer market in the past two years and are expected to continue once capacity is released in 2023/24.
FOCUS ON THE CHINESE POWER SiC ECOSYSTEM

SiC Boule/Substrate | SiC Epitaxy | Chip Processing | Diode/Transistor Design | Module Packaging | System

CETC Institute 13 and 55 and Shanxi Semicore Crystal co. (named as SEMISiC)
CETC Institute 2 has internal substrate capacity, mainly for SiC substrates.

BYD Semiconductor

Global Energy Interconnection Research Institute

Some Chinese companies don’t have the same name in Chinese and English. The following is a word for word translation of well-known companies’ Chinese names for ease of reference for non-Chinese speakers.
TankeBlue: Tianke Heda
SICC: ShanDong Tianyue
Synlight: Hebei Tongguang

* HDSC owns CECS, GTA and ASMC

Non-exhaustive list
There are more than 50 companies in the Chinese SiC ecosystem.
INVESTMENT AND FINANCING ANNOUNCEMENTS IN CHINA IN ONE YEAR

>$10B RMB (>1.5B) announced during 2022-2023/Q3

The announced investments in Power SiC in China were >10B RMB (>1.5B) in 2022-2023/Q3.

It illustrates the strong momentum in this country to be deeply involved in the ecosystem and to develop a domestic supply chain to build strategic positions.

Multiple financing activities and investments at this level have been announced as well. It helps to create an end-to-end domestic supply chain in China.

- **Financing activities**
  - Capacity expansion or new facility build-up

- **Material and equipment**

- **Wafer**
  - SICC: IPO, Shanghai fab opening
  - TYSIC: Pre-IPO series
  - 超芯星科技: Pre-B series >100M RMB
  - Synlight

- **Epiwafer**
  - IVCT: Pre-B series >100M RMB, B series >100M RMB
  - EpiWorld International

- **Chip Process**
  - 超芯星科技: Pre-B series >100M RMB
  - Sanan IC: A+ series
  - 三安光电: JV company with STMicroelectronics

- **Module**
  - BYD Semiconductor: IPO suspension

- **Non-exhaustive list**
  - 新华电子: IPO
  - 新兴电子: IPO
  - 超芯星科技: IPO

**Capacity expansion or new facility build-up**
- New fab for 8" wafer (~7B RMB)
SIC WAFER AND DEVICE CAPACITY OF CHINESE PLAYERS

Massive expansion in SiC wafer

* Real production refers to the total volume shipped by wafer and device manufacturers. It’s a function of total capacity, utilization rate, product mix of 6” and 8”, production yield, lead-time …etc.

If capacity is no more the concern, then cost, quality and stable supply are the keys to win the competition.
ANALYZED SiC DIODES FROM CHINESE PLAYERS
Source: SiC Diode Comparison 2023 – Yole SystemPlus

WeEn semiconductors
WN5C10650W

InventChip
IV1D06006O2

Package Opening – Optical View
©Yole SystemPlus 2023

650V SiC Diode Total Wafer & Die Ampere Cost Breakdown

US Competitor

3,200 $
$/A 0.060

1,600 $
$/A 0.030

0 $
$/A 0.000

Raw wafer Price (SiC 150mm)
Epitaxy cost
Epi Foundry margin
FE Cost
FE Foundry margin
Probe test & Dicing
Epitaxy Yield losses Cost
FE Yield losses Cost
Ampere cost ($/A) at Tc=125°C
ANALYZED SiC TRANSISTORS FROM CHINESE PLAYERS

Source: SiC Transistor Comparison 2023 – Yole SystemPlus

- The FoM diminishes, improving the design.
- Trench structure showed the best FoM until 2020-2021 from which latest planar technologies start to compete trench devices.

Note: On resistance Rds(on) values are taken from datasheet and are impacted by device package (not measured at bars [Ω]).

1200V SiC MOSFET Technologies’ Fom (rdson*Vq) Evolution
©Yole SystemPlus 2023

©Yole SystemPlus 2023
ANALYZED SiC MODULES FROM CHINESE PLAYERS

Source: Yole SystemPlus Reports (SPR22679 & SPR23792)

BYD

Application: Automotive

BYD – BM840F12B34U2

Package Opening & Cross-section – Optical View
©Yole SystemPlus 2023

SiC die
Ceramic substrate

Application: Industrial

StarPower – GD820HTX75P6H

Package Opening & Cross-section – Optical & SEM View
©Yole SystemPlus 2023

SiC die
Ceramic substrate
Baseplate
Power SiC/GaN Compound Semiconductor Market Monitor
• **KEY MESSAGES**

  o SiC device revenue reached $1.8B in 2022, with a growth of 62%. It reflected to the SiC wafer shipment, more than 570k 6"-eq. units have been shipped globally in 2022.

  o Top 6 device players acquired nearly 90% of the market in the past 2 years However, we've seen wafer players taking 5% of the market share in the past year, including SK siltron css and Chinese players TankeBlue and SICC.

  o Chinese companies invested heavily in SiC business, especially for SiC wafer. And there’re multiple players at each level of the supply chain as of 2023.

  o There’re Chinese discrete SiC diodes, MOSFETs and power modules analyzed, in terms of cost, performance and the approaches of packaging.
COMPUTING: The Chinese processor ecosystem keeps expanding relentlessly
Processor revenue is expected to reach $275B in 2028.

<table>
<thead>
<tr>
<th>Market</th>
<th>2022 Revenue</th>
<th>2028 Revenue</th>
<th>CAGR 2022-2028</th>
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<tbody>
<tr>
<td>Mobile &amp; Consumer</td>
<td>$111B</td>
<td>$114B</td>
<td>0.5%</td>
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<tr>
<td>Automotive</td>
<td>$10B</td>
<td>$15B</td>
<td>10%</td>
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<tr>
<td>Telecom &amp; Infrastructure</td>
<td>$42B</td>
<td>$25B</td>
<td>19%</td>
</tr>
<tr>
<td>Industrial and others</td>
<td>$10B</td>
<td>$15B</td>
<td>7%</td>
</tr>
</tbody>
</table>

CAGR\textsubscript{2022-2028} = 8%
PROCESSOR REVENUE FORECAST

2022-2028 processor revenue forecast, by type of processor

Processor revenue is expected to reach $275B in 2028.

APU: CAGR\textsubscript{22-28} = 1%
CPU: CAGR\textsubscript{22-28} = 7%
GPU: CAGR\textsubscript{22-28} = 16%
DPU: CAGR\textsubscript{22-28} = 53%
AI ASIC: CAGR\textsubscript{22-28} = 38%
SoC FPGA: CAGR\textsubscript{22-28} = 12%
MCU: CAGR\textsubscript{22-28} = 5%

CAGR\textsubscript{22-28} = 8%
FOCUS ON GREATER CHINA
Chinese processor companies, by type of processor

CPU
- PC
- Data center
- CPU
- GPU
- FPGA
- APU
- GPU
- Fabless
- IDM

Non-exhaustive list

FOCUS ON GREATER CHINA
Chinese processor companies, by type of processor

CPU
- PC
- Data center
- CPU
- GPU
- FPGA
- APU
- GPU
- Fabless
- IDM

Non-exhaustive list
AUTOMOTIVE PROCESSOR COMPANIES
A large variety of competitors and strategies

- Mobile and infotainment
- Server processor providers
- Vision processors
- Start-ups for ADAS/AD and AI
- Start-ups for cockpit SoCs

Historical automotive MCU providers

Automotive OEMs

Central processor for ADAS/AD

Multisensor APUs

ADAS VPs

Hybrid MCU

MCU

Low consumption

System control

First level of intelligence

Audio, basic detection

Content recognition

Object & pattern, basic classification, line detection

Context awareness

SCM, advance classification, map construction, sensor fusion

Decision

Prediction, decision

Computing performance

Start-ups for cockpit SoCs

Toshiba

Ambarella

Mobileye

AMD

Xilinx

Texas Instruments

Infinion

NMC

Renesas

Tesla

LG

NIO

Leapmotor

BYD

Semdrive

Siengineering

Horizon Robotics

Sing3o

Haild Robotics

Black Sesame

Blaize

Rockchip

Qualcomm

Samsung

MediaTek

Autel

i7 silicon

Intel

Nvidia

Autel

i7 silicon

Intel

Nvidia
## PROCESSOR FOR AUTOMOTIVE APPLICATION

### Example for ADAS Processor

<table>
<thead>
<tr>
<th>Application</th>
<th>Manufacturer</th>
<th>Reference</th>
<th>Vehicle Autonomy</th>
<th>Performance</th>
<th>Power Consumption</th>
<th>Package</th>
<th>Process Node</th>
<th>Die Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central System</td>
<td>HiSilicon</td>
<td>Ascend 610</td>
<td>≥ L4</td>
<td>200+ TOPS</td>
<td>60 W</td>
<td>FCBGA 3,600</td>
<td>7 nm</td>
<td>TSMC</td>
</tr>
<tr>
<td>Central System</td>
<td>NVIDIA</td>
<td>Orin</td>
<td>L2+ to L5</td>
<td>200 TOPS</td>
<td>60 W</td>
<td>FCBGA 2,648</td>
<td>8 nm</td>
<td>Samsung</td>
</tr>
<tr>
<td>Multi-camera</td>
<td>Mobileye</td>
<td>Eye Q5H</td>
<td>L2+ to L4</td>
<td>16 DL TOPS</td>
<td>&lt; 10 W</td>
<td>FCBGA 1,508</td>
<td>7 nm</td>
<td>TSMC</td>
</tr>
<tr>
<td>Multi-camera</td>
<td>Mobileye</td>
<td>Eye Q5M</td>
<td>L2+ to L4</td>
<td>16 DL TOPS</td>
<td>&lt; 10 W</td>
<td>FCBGA 896</td>
<td>7 nm</td>
<td>TSMC</td>
</tr>
<tr>
<td>Multi-camera</td>
<td>Tesla</td>
<td>FSD Chip UBQ01B0</td>
<td>Up to L5</td>
<td>37 DL TOPS</td>
<td>36 W</td>
<td>FCBGA 2,116</td>
<td>14 nm</td>
<td>Samsung</td>
</tr>
<tr>
<td>Camera</td>
<td>Renesas</td>
<td>R- Car V3H</td>
<td>Up to L4</td>
<td>7.2 TOPS</td>
<td>-</td>
<td>FCBGA 538</td>
<td>16 nm</td>
<td>TSMC</td>
</tr>
<tr>
<td>Camera</td>
<td>Xilinx</td>
<td>UltraScale+ XAZU3EG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>FCBGA 625</td>
<td>16 nm</td>
<td>TSMC</td>
</tr>
</tbody>
</table>
PROCESSOR FOR AUTOMOTIVE APPLICATION

Tesla

Tesla Autopilot 3.0

Tesla Autopilot 4.0

FSD HW3 Chip

LPDDR4

FSD HW4 Chip

GDDR6
PROCESSOR FOR CONSUMER APPLICATION

Apple A17 Pro Chip in iPhone 15 Pro Max

First TSMC 3nm consumer product!
PROCESSOR FOR CONSUMER APPLICATION
HiSilicon 9000s in Huawei Mate 60 Pro

Package: MCeP like (OSAT)
Die manufacturing: SMIC

Teardown
• **KEY MESSAGES**

  o Processor revenue is expected to reach $275B in 2028, with a CAGR$_{22-28}$ of 8%. Datacenter processors will represent the biggest share of the revenue in 2028.

  o The computing ecosystem in China is strongly developing in all technologies and markets, pushed by the Chinese government incentive policy.

  o Processor for the automotive market is particularly dynamic, boosted by the growing domestic market.

  o In both consumer and automotive industry, domestic supply chain is rising.

  o More advanced processor die manufacturing is now used for automotive application.
MEMORY – China memory business: no signs of slowing down
• Memory is one of the primary market segments for semiconductor products. In 2022, combined NAND and DRAM revenues corresponded to about 23% of the overall semiconductor market.
SEMICONDUCTOR MEMORY MARKET OVERVIEW

2022 memory market – Breakdown by technology

- **$144B** in 2022

- **$58.7B** (40.8%)
- **$79.7B** (55.4%)
- **$3.2B** (2.2%)
- **$1.0B** (0.7%)
- **$0.6B** (0.4%)
- **$0.67B** (0.5%)
- **$79.7B** (55.4%)

Revenue ($B)

NAND and DRAM market evolution

- **Source:** DRAM and NAND market monitors (Q2-2023) by Yole Intelligence

Notes

Memory revenues include chips and wafers, as well as memory modules and solid-state drives sold by IDM memory companies.
MEMORY MARKET TRENDS

Memory Wafer Volume Evolution (NAND and DRAM)
in Million 12” Wafers per Year

Wafer Volume Growth Rates (%)

- PC/Client CAGR\textsubscript{22-28} -6%
- Data Center CAGR\textsubscript{22-28} 9%
- Mobile CAGR\textsubscript{22-28} -7%
- Consumer CAGR\textsubscript{22-28} -8%
- Automotive CAGR\textsubscript{22-28} 17%
- Other CAGR\textsubscript{22-28} -2%

Source: DRAM and NAND market monitors (Q2-2023) by Yole Intelligence
China is a top market for stand-alone memory. China accounts for more than 1/3 of worldwide NAND and DRAM sales.

**Geographical Breakdown of NAND DRAM Sales***

*The geographical breakdown of 2023 memory sales is estimated using Q1-Q3 2023 revenue data.

**Source:** DRAM and NAND market monitors by Yole Intelligence
China is a key market for all leading memory suppliers

**DRAM Sales in 2022**

- Samsung: $30B, 55% Sales in China, 19% Sales in Other Countries
- SK hynix: $36B, 31% Sales in China, 19% Sales in Other Countries
- Micron: $20B, 19% Sales in China, 36% Sales in Other Countries
- Nanya: $5B, 19% Sales in China, 0% Sales in Other Countries
- Winbond: $10B, 0% Sales in China, 0% Sales in Other Countries
- PoMC: $0B, 0% Sales in China, 0% Sales in Other Countries

Source: “Status of the Memory Industry 2023” report by Yole Intelligence

**NAND Sales in 2022**

- Samsung: $25B, 31% Sales in China, 36% Sales in Other Countries
- Kioxia: $10B, 31% Sales in China, 24% Sales in Other Countries
- WDC: $5B, 42% Sales in China, 16% Sales in Other Countries
- Micron: $4B, 36% Sales in China, 19% Sales in Other Countries
- SK hynix: $2B, 19% Sales in China, 19% Sales in Other Countries
- Solidigm: $1B, 16% Sales in China, 0% Sales in Other Countries

Source: “Status of the Memory Industry 2023” report by Yole Intelligence
MEMORY PLAYERS IN MAINLAND CHINA

Non-exhaustive list!

- **SAMSUNG**
  - Xian (Assembly & test)
  - Xi'an (3D NAND)
  - Xi'an (DRAM)

- **Micron**
  - Wuhan (3D NAND)

- **GigaDevice**
  - Beijing (Fabless, NOR)

- **SK Hynix**
  - Dalian (3D NAND) - Fab sold by Intel to SK Hynix, transfer by 2025

- **UniiC**
  - Xi'an (DRAM)

- **Jiangsu**
  - Jiangsu (PCM)

- **Wuxi**
  - Wuxi (DRAM)

- **Beijing**
  - Beijing (MRAM)
  - Beijing (RRAM)
  - Xi'an (Assembly & test)

- **Shanghai**
  - Shanghai (MRAM)
  - Shanghai (RRAM)
  - Shanghai (NOR)

- **Hangzhou**
  - Hangzhou (MRAM)

- **Shenzhen**
  - Shenzhen (NOR)

- **Hefei**
  - Hefei (DRAM)

- **Xi'an**
  - Xi'an (3D NAND)
  - D NAND

- **Source:** “Status of the Memory Industry 2023” report by Yole Intelligence
US restrictions are hampering the growth of the China memory industry.

CXMT and YMTC are looking for alternative solutions to continue executing their roadmaps.

**Source:** “Status of the Memory Industry 2023” report by Yole Intelligence
• In November 2022, YMTC started shipping its fourth-generation 3D NAND with 232 layers based on Xtacking™ 3.0, reaching this milestone before its competitors.

Source: Yole SystemPlus’ 2023 report “YMTC 232-layer 3D NAND Memory”
Chinese players are developing and adopting hybrid bonding interconnection technology as an alternative to dimensional scaling. 

**In 2022**, Alibaba Damo demonstrated results of 3D logic to DRAM hybrid bonding D2W interconnection. In the future, the company is targeting multi-bank DRAM to AI processor logic.

**In 2022**, SunLune Corporation launched its Jasminer X4 Miner product with W2W hybrid bonding connection of DRAM to logic for crypto mining. Logic die is probable to be fabricated on XMC technology.

**In 2020**, IC League published results on HITOC, which uses D2W hybrid bonding for logic die on DRAM wafer 3D stacking.

**In 2018**, YMTC launched a 3D NAND product using W2W hybrid bonding technology. It was the first 3D NAND stack to use hybrid bonding.
• SunLune introduced an innovative ASIC chip based on 3D IC technology platform. This incorporates a logic die and DRAM die bonded together through copper-to-copper hybrid bonding to increase chip bandwidth.

• With its leading 3D integrated and high-throughput ASIC, SunLune designed this chip targeting the crypto world. This chip enables high throughput, high computing power and low power consumption in crypto mining applications thanks to the new 3D IC architecture.

Source: Yole SystemPlus’ 2023 report “Jasminer X4-Q Mining ASIC with DBI”
• **KEY MESSAGES**

- China is a key market for NAND and DRAM suppliers:
  - Sales to companies headquartered in China account for more than 1/3 of the total memory market revenue.

- US trade restrictions are slowing down the execution of NAND and DRAM roadmaps by YMTC and CXMT. However, they will not stop China’s ambitions to become a leading memory player.

- In the coming years, Chinese companies will increase their focus on the following technology areas:
  1. Advanced packaging for memory-logic integration
  2. Memory scaling methods alternative / complementary to conventional lithography shrinks (e.g. 3D DRAM)

- Leveraging on these More-than-Moore solutions, China will be able to remain in the race for technology leadership in various fields, among which the critical sector of AI computing.
Packaging: Is Great China Mainland OSAT Compatible with Global OSAT?
FINANCIAL OVERVIEW FOR TOP 30 PLAYERS

Revenue in 2022

TOP 30 players ranking by 2022 revenue [$M]

- ASE (with SPI)...
- Amkor...
- Intel...
- TSMC...
- JCT...
- Samsung...
- Tongfu...
- Powertech...
- Tianshui Huatian...
- UTAC...
- King Yuan...
- Hana Micro...
- Chipbond...
- ChipMOS...
- Sigurd...
- Hitech Semi...
- SFA Semicon...
- SJ Semi...
- Carsen...
- Greatek...
- OSE...
- Ardentec...
- Nepes...
- Tong Hsing...
- Payton...
- Unisem...
- LB Semicon...
- Formosa...
- Inari...
- Forehope...

Revenue in 2022:
- $317M
- $336M
- $339M
- $404M
- $406M
- $448M
- $457M
- $467M
- $472M
- $505M
- $519M
- $526M
- $537M
- $555M
- $556M
- $581M
- $608M
- $617M
- $647M
- $649M
- $656M
- $673M
- $726M
- $765M
- $781M
- $798M
- $846M
- $848M
- $852M
- $872M
- $970M
- $1197M
- $1726M
- $197M
- $226M
- $2730M
- $3107M
- $3895M
- $500M
- $519M
- $537M
- $555M
- $581M
- $608M
- $647M
- $649M
- $673M
- $681M
- $726M
- $765M
- $798M
- $846M
- $848M
- $852M
- $872M
- $970M
- $1197M
- $1726M
- $197M
- $226M
- $2730M
- $3107M
- $3895M
- $519M
- $537M
- $555M
- $581M
- $608M
- $647M
- $649M
- $673M
- $681M
- $726M
- $765M
- $798M
- $846M
- $848M
- $852M
- $872M
- $970M
- $1197M
- $1726M
- $197M
- $226M
- $2730M
- $3107M
- $3895M

Top 3 GC Mainland OSATs in 2022 ~ 80% of market share.
Part of the Top 10 Global OSATs.

Remaining GC Mainland OSATs ~ 20% of market share.
### TOP 10 GREATER CHINA MAINLAND OSAT REVENUES

#### Top GC Mainland OSAT Rankings by 2021 Revenue ($M)

<table>
<thead>
<tr>
<th>Company</th>
<th>Revenue ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCET Group</td>
<td>4,841</td>
</tr>
<tr>
<td>Tongfu Microelectronics</td>
<td>2,394</td>
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<tr>
<td>Tianshui Huatian</td>
<td>1,902</td>
</tr>
<tr>
<td>Hitech Semiconductor</td>
<td>567</td>
</tr>
<tr>
<td>Payton Technologies</td>
<td>406</td>
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<tr>
<td>China Resources Microelectronics</td>
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<tr>
<td>Forehope Electronic</td>
<td>320</td>
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<tr>
<td>Chipmore Technology</td>
<td>224</td>
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<tr>
<td>SJ Semi</td>
<td>223</td>
</tr>
<tr>
<td>China Wafer Level CSP</td>
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#### Top GC Mainland OSAT Rankings by 2022 Revenue ($M)

<table>
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<th>Company</th>
<th>Revenue ($M)</th>
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<tr>
<td>China Resources Microelectronics</td>
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</tr>
<tr>
<td>Unimos Microelectronics</td>
<td>188</td>
</tr>
</tbody>
</table>

#### Top GC Mainland OSAT Rankings by H1 2023 Revenue ($M)

<table>
<thead>
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<th>Company</th>
<th>Revenue ($M)</th>
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<td>Tianshui Huatian</td>
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<tr>
<td>Payton Technologies</td>
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<tr>
<td>Unimos Microelectronics</td>
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<tr>
<td>Hitech Semiconductor</td>
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<tr>
<td>Forehope Electronic</td>
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</tr>
<tr>
<td>China Resources Microelectronics</td>
<td>109</td>
</tr>
<tr>
<td>Chipmore</td>
<td>98</td>
</tr>
</tbody>
</table>

The top ten GC Mainland OSATs' total revenues grew 8% from 2021 to 2022, from $11.4B to $12.2B. JCET, TFME and Huatian remain the top three Chinese players and part of the worldwide top ten OSAT ranking.
Great China Mainland OSATs are mainly focusing on mid-end Advanced Packaging platforms and targeting high-end technologies for the future.
GLOBAL’S OSAT OVERVIEW BY PRODUCTS

AOI Electronics
Globetronics
Inari
Unisem
Carsem
NEPES
LB Semicon
SFA
Hana Micron
UTAC
Arnkor
SJ Semi
Hiten
Tail Semi
Chipmacking
Forehope
CRM
Chipmore
WLCSP
Payton
Huatian
TFME
JCET
Lingsen
A.E.
Ardentec
Aronix
Kogasage
Sigurd
OSE
Greatek
Chipbond
ChipMOS
KYEC
PTI
ASE

Technologies:
- SiP
- 3D
- FO
- WLCSP
- Flip-Chip
- Traditional PKG
**GC MAINLAND - TOP ADVANCED PACKAGING INVESTMENTS IN 2023**

**Micron** will acquire PTI’s Xi’an packaging plant in China and plans to invest CNY4.3B (~US$602M).

**Huatian** announced an investment of about US$416M (RMB 2.858 billion) in a new advanced packaging plant aiming to create capacity for wafer bumping, WLCSP and UHD FO packaging and testing.

**SJ SEMI** raised almost US$340M in a first batch of investment, which will help the company to expand the second phase of its 3D multi-chip integration and packaging project.

**Longsys** completed its US$132M takeover of Powertech Technology (Suzhou).

**JCET** holding company, JCET Automotive Electronics (Shanghai) Co., Ltd., will receive a capital increase of RMB 4.4B (~US$600M) resulting in a capital of RMB 4.8B (~US$655M), to accelerate the construction of an advanced packaging facility for automotive products.

**Forehope Electronic** announced the opening of part of its 2nd phase fab expansion and production capacity. The total planned investment for the 2nd phase fab is 11.1B RMB (~US$1.52B).

**China Resources Microelectronics** (CR Micro) has kickstarted an advanced backend site in Chongqing, China. The Chongqing branch of CR Micro, named SiPLP, and its back-end site will focus on testing and packaging power semiconductors utilizing panel-level packaging processes.

**ECHINT** ESWIN FOPLP business, established in July 2017, was renamed Chengdu ECHINT Technology Co., Ltd in 2023. ECHINT has built the first high-density PLP factory in the Chinese mainland with a total investment of US$800M and expects to achieve LVM in Q4 2023.
• **KEY MESSAGES**

o Great China Mainland has a total of 7 OSATs listed in top 30 global OSATs

o **Top 3 OSAT**, JCET, TFME and Huatian have around 80% of the market share in Great China Mainland.

o Most of the Great China Mainland OSATs focusing on mid-end packaging platform, with few OSATs focusing on high-end packaging technology.

o More investment announcement to expand or set up a new packaging manufacturing site in Greater China Mainland.

In summary, Great China Mainland OSATs is compatible with global OSATs. They will have more advanced packaging capability and aim to continue strengthening the global position.
WFE: Is China WFE able to support domestic chip manufacturing?
Is China WFE able to support domestic chip manufacturing?

Mainland China can be independent only, if the whole chip manufacturing infrastructure is domestic. Here we focus on the **Wafer Fab Equipment**.

We need to understand:

1. Current Mainland China semiconductor device needs, which is related to,
2. Mainland China Chipmaker production capacity vs their investment in WFE, compared to,
3. Current production and technology capacity of WFE companies.
• Mainland China is a market in itself, with a large appetite for semiconductor chips. Domestic semiconductor chip production is much lower than state’s chip consumption. Despite the growth over last 5 year, currently, less than 15% of all semiconductor devices used for domestic market are manufactured in China. Hence, it is important to build own manufacturing capacity.

• Domestic chip revenue is generated from domestic and international firms.
• WFE shipments to China increased from several years, QoQ, hiking up to as high as 40% of total in Q3 2023.
• Similar to semiconductor device consumption, most of WFE is imported and only 11% originates from domestic suppliers.

**MAINLAND CHINA WFE CONSUMPTION**

- WFE worldwide revenue with a breakdown to the destination region.
- 2022 Foreign WFE import revenue vs domestic WFE revenue.
- Mainland China WFE consumption.
- China WFE imports 89%.
- Domestic and international chipmakers.
- Mainland China 89% and Other regions 11%.

$23B
## CAN CHINA RELY ON DOMESTIC SUPPLIERS ONLY?

<table>
<thead>
<tr>
<th>Market Leaders</th>
<th>Thinning and CMP</th>
<th>Deposition /Anneal</th>
<th>Etch and Clean</th>
<th>Ion Implant</th>
<th>Patterning - Exposure</th>
<th>Patterning - Resist</th>
<th>Metrology and Inspection</th>
<th>Wafer Bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>International – Logic and Memory</td>
<td><a href="#">Applied Materials</a></td>
<td><a href="#">Lam Research</a></td>
<td><a href="#">TEL</a></td>
<td><a href="#">ASML</a></td>
<td><a href="#">TEL</a></td>
<td><a href="#">KLA</a></td>
<td><a href="#">ON Semiconductor</a></td>
<td><a href="#">EVG</a></td>
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<tr>
<td>(advanced and mature)</td>
<td></td>
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<tr>
<td>International – Specialty</td>
<td><a href="#">DISCO</a></td>
<td><a href="#">ASM</a></td>
<td><a href="#">KLA</a></td>
<td><a href="#">Axcelis</a></td>
<td><a href="#">Canon</a></td>
<td><a href="#">Screen</a></td>
<td><a href="#">SUSS MicroTec</a></td>
<td><a href="#">SURE MicroTec</a></td>
</tr>
<tr>
<td>China Replacement in 2023 ?</td>
<td>Partially</td>
<td>Possible but limited by China WFE vendor production capacity</td>
<td>NO</td>
<td>i-line only</td>
<td>Possible but limited by capacity</td>
<td>NO</td>
<td>NO</td>
<td></td>
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<tr>
<td>Possible China WFE Vendor</td>
<td><a href="#">AMEC</a></td>
<td><a href="#">Naura</a></td>
<td><a href="#">ACM</a></td>
<td>[CETC, Kingstone (previously in PV)]</td>
<td></td>
<td></td>
<td></td>
<td>[失踪半导体]</td>
</tr>
</tbody>
</table>

Non-Exhaustive list

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## MAINLAND CHINA WFE VENDOR CAPABILITIES

<table>
<thead>
<tr>
<th>Manufacturing node</th>
<th>Thinning and CMP</th>
<th>Deposition/Anneal</th>
<th>Dry Etch and Clean</th>
<th>Wet Etch and Clean</th>
<th>Ion Implant</th>
<th>Patterning - Exposure</th>
<th>Patterning - Resist</th>
<th>Metrology and Inspection</th>
<th>Wafer Bonding</th>
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<td>≥90 nm</td>
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<td>≥28 nm</td>
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<td><img src="image" alt="NAURA" /></td>
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<td><img src="image" alt="SRI" /></td>
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<td><img src="image" alt="KINGSEMI" /></td>
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<td><img src="image" alt="LASIC" /></td>
</tr>
<tr>
<td>≥14 nm</td>
<td><img src="image" alt="HWATSING" /></td>
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<td><img src="image" alt="In development" /></td>
<td><img src="image" alt="KINGSEMI" /></td>
<td><img src="image" alt="LASIC" /></td>
<td><img src="image" alt="In development" /></td>
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</tr>
<tr>
<td>≥5 nm</td>
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<td></td>
<td></td>
<td></td>
<td><img src="image" alt="In development" /></td>
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<td></td>
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</tr>
</tbody>
</table>

*Non-Exhaustive list*
China companies showed an extraordinary growth in 2023, following the success in 2022 and 2021.
WFE CONCLUSION

• KEY MESSAGES

o China Mainland pays for approximately 30% of worldwide semiconductor revenue. Domestic manufacturing capacity is needed!

o China Mainland invests greatly in the manufacturing capacity and WFE, from which domestic WFE accounts in 2022 for only 11% of total domestic need.

o As of 2023, domestic WFE vendors cannot satisfy all WFE technologies needed, despite rapid development with public and private investments.

o Nevertheless, domestic WFE vendors show growth in terms of capabilities and revenue generation, even during a global 2023 WFE market downturn.

In summary, China Mainland WFE will grow in a sustainable way propelled by both technology push and market pull.