

MATERIALS – “The Achilles Heel” to the Expanding Chip Industry

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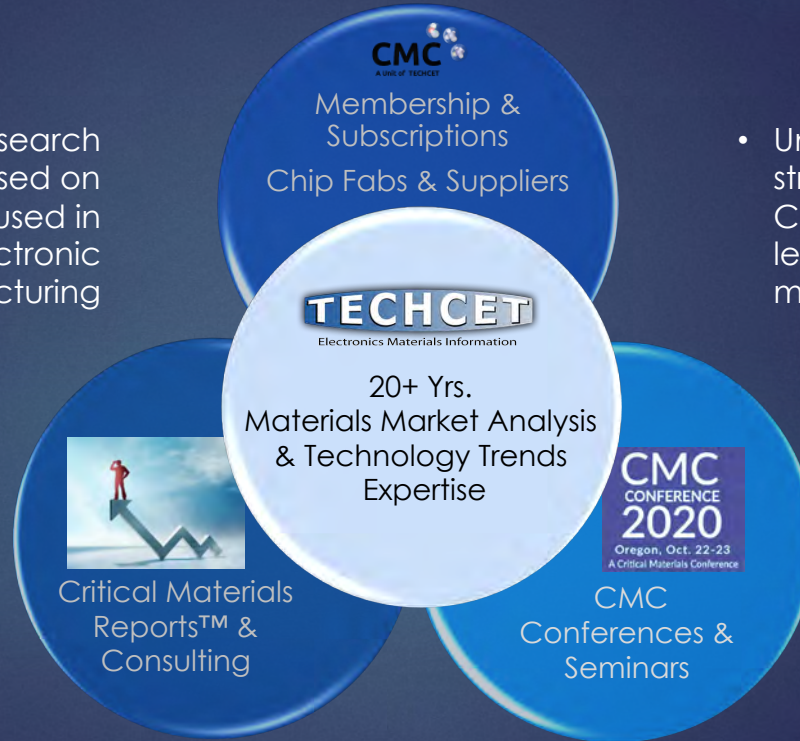
TECHCET

Electronics Materials Information



Who is TECHCET?

- Specialized in market research & consulting focused on materials used in semiconductor & electronic device manufacturing
- Critical Materials Reports™ & consulting since 2000
 - 20 years of data on electronic materials



- Unique industry insights strengthened by TECHCET's Critical Materials Council – leading chip fabs and materials suppliers
- The CMC Conferences provide actionable information essential to the industry

Outline

- ▶ Semiconductor Market Expansion Upsurge
- ▶ Materials
 - ▶ Wafers
 - ▶ Equipment Components
 - ▶ Chemicals
- ▶ Logistics
- ▶ Take Aways

READERS NOTE

This report represents the interpretation and analysis of information generally available to the public or released by responsible agencies or individuals. Data was obtained from sources considered reliable. However, accuracy or completeness is not guaranteed.

Markets Recovering with Some Uncertainty

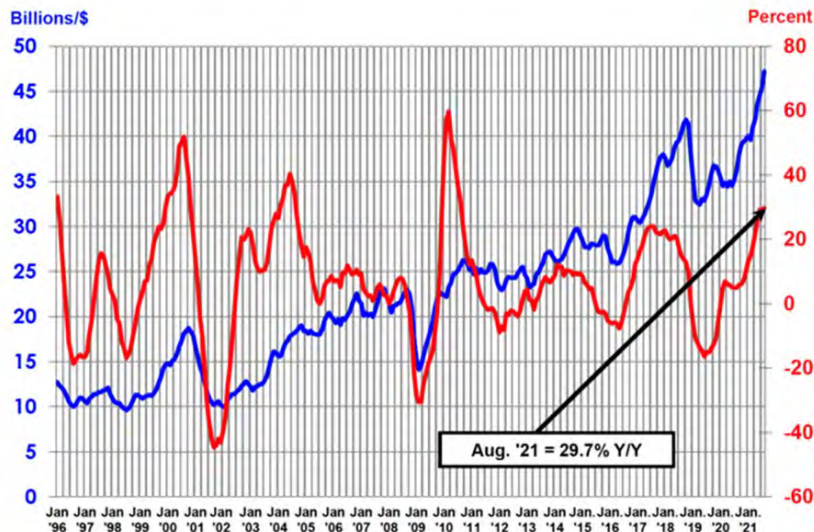
- ▶ GDP recovers for all advanced economies
- ▶ Top Macro challenges to growth include
 - ▶ Economics – growing inflation
 - ▶ Geopolitics – especially between US/China
 - ▶ Length and severity of pandemic
- ▶ 2021 Semiconductor market is forecasted experience $\geq 20\%$ revenue growth
- ▶ Top Semiconductor Industry Challenge
 - ▶ Supply Chain Issues in the midst of an Upsurge in demand and chip expansions



Semiconductor Sales Growth

Worldwide Semiconductor Revenues

Year-to-Year Percent Change

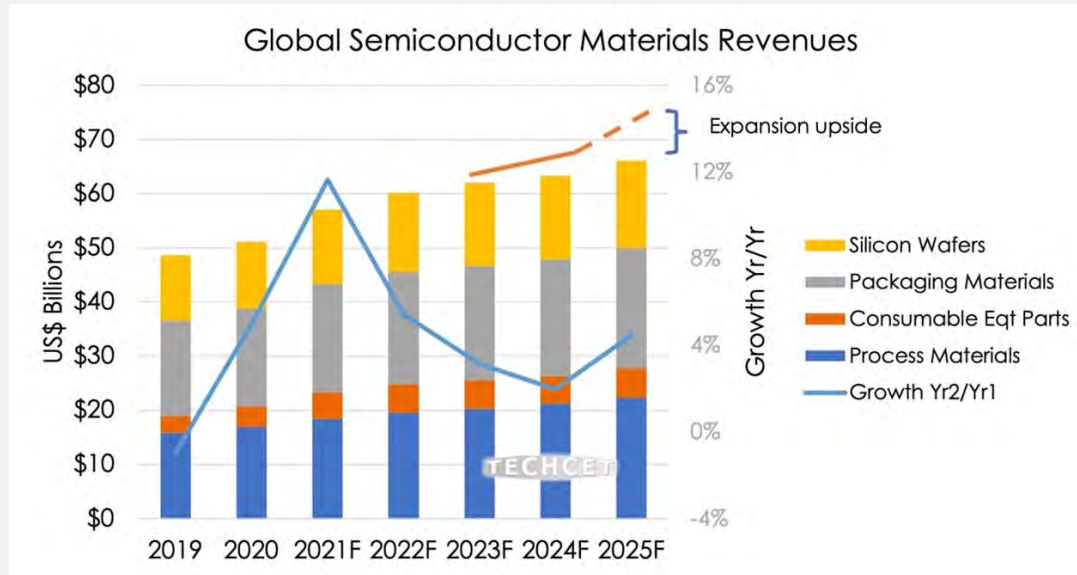


Source: WSTS/SIA,
TECHCET

- 2021 semiconductor chip revenues will top \$530 B; expected to exceed 20% growth
- Strong momentum continued into August
- Sales in August Up 29.7% Year-to-Year, 3.3% Month-to-Month
- Taiwan revenue indicators from January to Sept show $\geq 20\%$ consistently strong growth YoY.

TEHCET's Materials Forecast

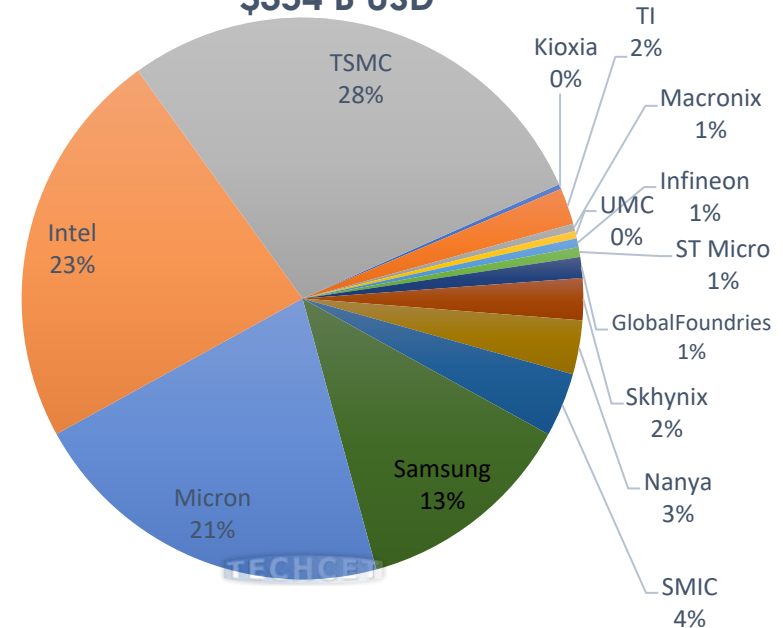
- 2021 semiconductor materials revenues will top \$57B, >11% vs. 2020
- 5.3% CAGR estimated (2021 to 2025)
- The highest growth segments include wafers, equipment components, precursors, cleans, CMP, and photoresists
- Wafers and chemical revenues are expected to get an extra boost - supply-demand strain will likely push up ASPs.
- Huge upside potential by 2025, from announced chip expansions



Fab Expansion Announcement Summary

- ▶ \$354 B USD of fab expansions 2021-2026
- ▶ Creating huge upswing in growth in the next 5 years
- ▶ Demand will drive growth in materials
- ▶ But will the materials companies be prepared for this upside?

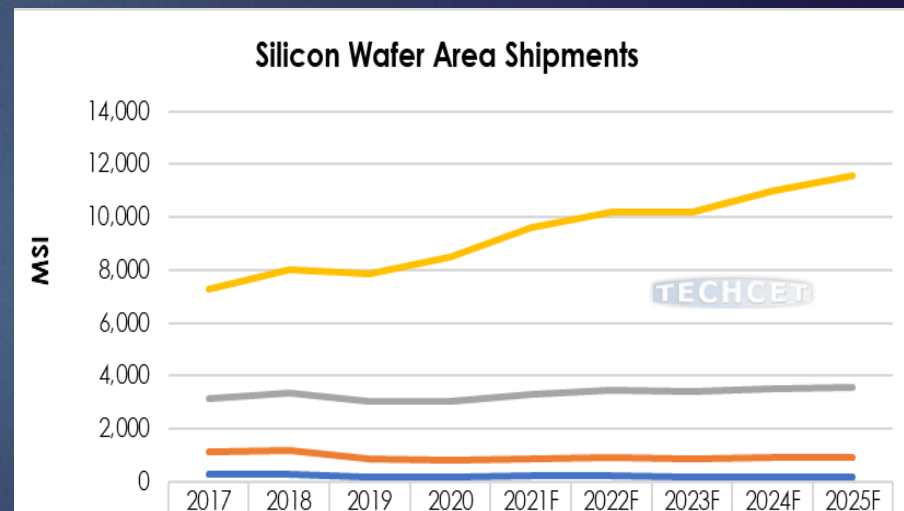
Chip Expansions 2021-2026
\$354 B USD



Wafer Market Booming and Supplies Tightening

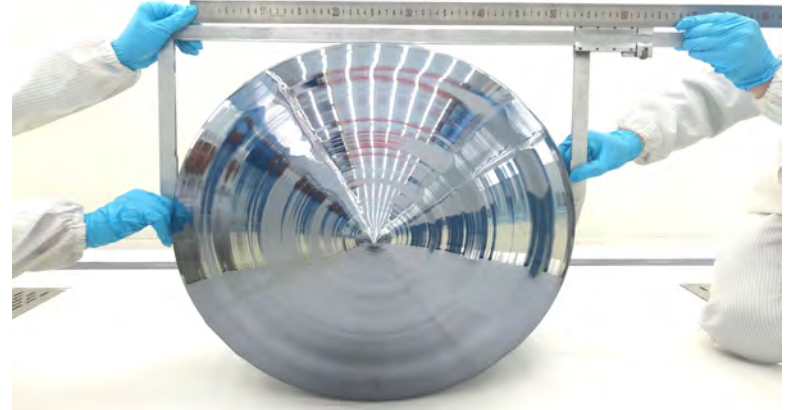
- ▶ Record high demand in 2021
 - ▶ 12% wafer shipment growth
- ▶ 300 mm wafer capacity is already tight
- ▶ Greenfield Expansion Plans
 - ▶ Siltronic in Singapore
 - ▶ Sumco in Japan
 - ▶ SK Siltron's announced investment
- ▶ But It will take another 2-3 years
- ▶ Wafers/Materials will be the limiting factor in chip production the Achilles Heel

Silicon Wafer Shipment Forecast (Updated October 2021)



Equipment Components Also in “Tight” Supply – Quartz, Si, SiC, Ceramics

- Parts fabrication supply is tight and lead-times running 2-3x longer than normal
 - Increased demand from equipment sales (>30% in 2021) and
 - Increased safety stocks
- Price and lead-time issues
- Significant capacity additions needed
- Many small Mom & Pop shops coming out to support Taiwan and Korea demand
- Possible recovery next year but another upswing in 2-3 years time creating another Achilles Heel / supply-crunch

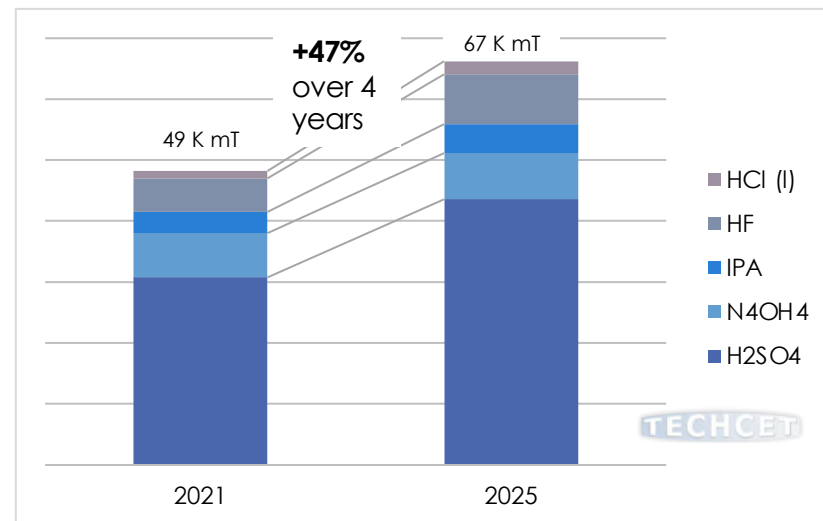


Silicon Parts fabricators are heavily reliant on silicon ingot making. The concern related to wafer market dependencies have led many major parts fabricators to grow their own ingots. Suppliers in China starting to compete: thinkon-cn.com

Chemical Demand Upsurge – Another Achilles Heel for US & Europe?

- ▶ Example: Europe Surveyed CMC Fabs & others chemicals demand projections to 2025
 - ▶ 47% (2021-2025)
 - ▶ ~20% (2016-2020)
- ▶ Demand growth will be more than double of historical rates
- ▶ ~30% imported – mostly high purity material is coming from Asia
- ▶ Can the supply chain continue support this?

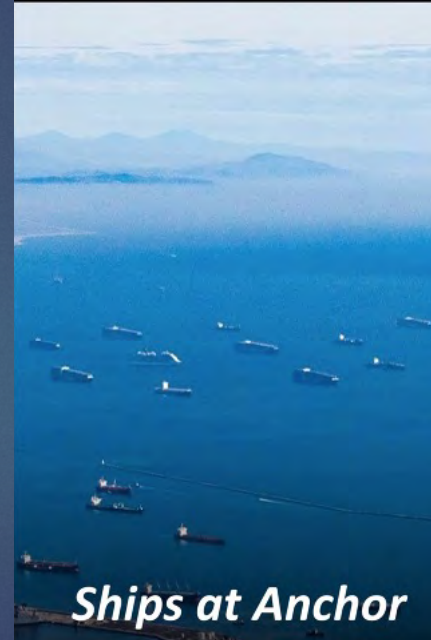
Impact of Expansions on European Chemical Demand



Logistics Troubles May Continue

- Serious delays on shipping – Ocean & Air
- COVID19 continues to disrupt transportation
 - Fewer flights
 - Heavily congested ocean freight ports
 - Shortage of trucks / truckers
- SHORT TERM: Port of Los Angeles expects logistics delays to subside in 2H2022next year, depending if COVID does not persist
- LONGER TERM: As climate change worsens, lengths and severity of storms will get in the way of timely local and international shipments

Congestion at Port of Los Angeles - October 2021



- 90 ships at anchor (65 container vessels)
- 28 ships enroute
- 12.5 days at anchor
- 17 ships/day at berth
- 70% higher than normal

Source: Port of Los Angeles

Materials Supplier Expansions are Few in Comparison to Chip Fabs

- ▶ Europe - 2 (wafers, chem)
- ▶ US – 7 (wafers, 4 chem, SiC, gas) – 5 are not built yet
- ▶ Korea – 3 (2-chem, photoresists)
- ▶ Taiwan – 4 (3-chem, precursors)
- ▶ China – capacity is available but much of it is unqualified
- ▶ Singapore/ SEA – 2 (ceramics, wafers)

Note: Chem or gas investments are typically only 1 type of chemical or gas

★ Take Aways

Achilles and Agamemnon –
Communication & Cooperation



Gottlieb Schick, Achille reçoit les ambassadeurs d'Agamemnon,
1801, collection particulière

- ▶ Semiconductor market “Hot”
- ▶ Materials pinch points will limit the overall pace of chip expansion
 - ▶ Wafers, Chemicals, Equipment Components, and others.
- ▶ Logistics problems will persist into next year or until COVID19 issues subside
- ▶ For the chip expansions, materials suppliers will need support to convince them to invest
 - ▶ Government subsidy
 - ▶ Longer term agreements
 - ▶ Outside the box thinking - agreements linked to economics?

TEHCET's Critical Materials

- | | |
|----|---|
| 1 | CMP Consumables (Pads/Slurry) |
| 2 | CMP Equipmt Consumables |
| 3 | CVD /ALD Hi K Precursors |
| 4 | CVD DIELECTRIC Precursors |
| 5 | Equipment Components – Quartz* |
| 6 | Equipment Components – Silicon* |
| 7 | Equipment Components – SiC/Ceramics* |
| 8 | Gases - Electronic Specialty, Bulk & Rare Gases |
| 9 | Metal Plating Chemicals+ |
| 10 | Photoresist, Ancillaries & Extension Materials |
| 11 | Sputter Targets |
| 12 | Silicon Wafers |
| 13 | Wet Chemicals / Specialty Cleaning Chemicals |
| 14 | Impact of Chip Expansions |
| 15 | Packaging Materials |

THANK YOU!

For more Info check out
<https://techcet.com> and
<https://cmcfabs.org>

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