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Eric Chen, DIGITIMES Research, February 2021

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Introduction

According to Digitimes Research's observation, the leading Taiwan-based foundries, including Taiwan Semiconductor Manufacturing Company (TSMC), United Microelectronics Corporation (UMC) and Vanguard International Semiconductor Corporation (VIS), generated aggregated total revenues of US\$14.58 billion in fourth-quarter 2020.

Their whole-year 2020 revenues exceeded US\$50 billion, setting a new high in history. The Taiwan-based foundries are expected to deliver robust performance in first-quarter 2021 despite the low season with customer demand remaining strong as well as foundries raising prices and expanding capacity. Their whole-year 2021 revenues are estimated to break the record again to top US\$60 billion.

The supply chain aggressively ramped up orders in fourth-quarter 2020 in view of COVID-19 uncertainties and digital transformation needs. On top of that, with new processors and end devices for 5G and high-performance computing (HPC) applications entering the market, IDM continuing to outsource chip production, the recovering automotive market driving automotive chip demand, as well as UMC and VIS hiking their 8-inch wafer prices, the leading Taiwan-based foundries' total revenues grew more than 4% quarter-over-quarter in fourth-quarter 2020, reaching a new high while boosting whole-year 2020 revenues to US\$52.69 billion, a strong 30.5% upsurge from a year ago.

Going into first-quarter 2021, the leading Taiwan-based foundries' total revenues are expected to show another 1.7% sequential growth with the ongoing COVID-19 pandemic, the supply chain ramping up orders, continuing digital transformation needs and IDM still outsourcing production to Taiwan-based foundries. As to whole-year 2021, aside from COVID-19-driven demand and IDM orders, the leading Taiwan-based foundries have allotted US\$28 billion in capital expenditure (up 50% from last year) to expand their capacity while raising foundry prices to cope with customer demand. As such, Digitimes Research expects their whole-year 2021 revenues to top US\$60 billion, growing 17% year-over-year.

Key factors affecting Taiwan's wafer foundry industry

Demand: 4Q20 and 1Q21

With COVID-19 still rampaging, the semiconductor supply chain maintains a high inventory level. Digitimes Research expects the semiconductor supply chain to keep ramping up orders through first-quarter 2021.

The demand for the 28nm process has been picking up since fourth-quarter 2020 and is likely to remain strong through first-quarter 2021.

SMIC's customers transferring orders and growing automotive chip demand offset the decline in the demand for mid-range and entry-level 4G phone application processors (AP), Wi-Fi-chips, OLED driver ICs due to seasonal factors.

New Apple 5G phones and AMD chips enjoyed brisk sales after entering the market in fourth-quarter 2020. The sales momentum will somewhat be curtailed by seasonal factors in first-quarter 2021.

Honor has returned to the 5G phone market after the spinoff from Huawei. The demand from its supply chain will recover starting first-quarter 2021.

With the automotive market recovering, the Taiwan-based foundries are receiving increasing orders for automotive chips. However, as priority has been given to other chips, foundry capacity for automotive chips will be tight in first-quarter 2021.

The shortage of automotive chips has impacted the production of leading automakers including Volkswagen, Ford, Toyota, Nissan and Fiat Chrysler.

Seeking production capacity, IDM customers keep placing orders with foundries.

IDMs including Intel, Samsung Electronics, Sony and NXP outsource the production of HPC chips, image signal processors (ISP) and automotive chips.

Due to seasonal factors, chip demand from end devices such as notebook computers and cloud servers will decline slightly compared to the prior quarter.

Table 1: Key factors affecting Taiwan's wafer foundry industry in 4Q20 and 1Q21 (demand)

Factor	Item	Influence on revenues	
		4Q20	1Q21
Demand	The supply chain keeps ramping up chip inventory to cope with COVID-19 uncertainties.	↑ ★★★	↑ ★★★
	The demand for the 28nm process continues to increase.	↑ ★★★	↑ ★
	Due to the large-volume shipments of 5G smartphone processors and HPC chips in 4Q20, the demand will fall back moderately in 1Q21 amid seasonal influences.	↑ ★★★	↓ ★
	After the spinoff from Huawei, Honor has returned to the 5G phone market, which spurs smartphone chip demand.	↑ ★	↑ ★
	The recovering automotive market is driving the demand for automotive chips but the capacity may be limited.	↑ ★	↑ ★
	IDM customers continue to place orders with Taiwan-based foundries.	↑ ★	↑ ★
	Semiconductor demand to meet WFH needs in 1Q21 will fall slightly compared to 4Q20.	↑ ★	↓ ★

Note: The more stars, the higher the influence. ↓ indicates negative influence, ↑ indicates a positive influence.

Source: Digitimes Research, February 2021

Supply: 4Q20 and 1Q21

According to Digitimes Research's observation, strong chip demand fueled the Taiwan-based foundries' shipments of 8-inch and 12-inch wafers in fourth-quarter 2020. The shipments of sub 16nm nodes may be affected by seasonal factors and fall moderately in first-quarter 2021. However, shipments of some mature processes will increase from the level of the prior quarter thanks to strong demand.

The capacity utilization of sub 16nm nodes will still maintain above 90%. In comparison, the capacity of 28nm and more mature processes will be tight.

The Taiwan-based foundries will continue to expand their 8-inch and 12-inch wafer capacity in first-quarter 2021 to keep up with customer demand.

TSMC will increase its 5nm capacity to 90,000 wafers per month and its combined 7nm and 6nm capacity to 140,000 wafers per month.

Its 5nm capacity was 80,000 to 85,000 wafers per month and its combined 7nm and 6nm capacity was 130,000 to 135,000 wafers per month in fourth-quarter 2020.

UMC's plan to expand the 28nm capacity at its Xiamen plant and Tainan plant is on track according to schedule.

Capacity expansion at its 8-inch fab in Singapore starting in first-quarter 2021 will boost the monthly capacity of VIS by 10,000 wafers.

To cope with market demand, UMC and VIS raised their foundry prices in fourth-quarter 2020 and will do so again in first-quarter 2021.

UMC will hike the price for its 12-inch wafer.

VIS will not rule out the possibility of raising its 8-inch wafer price again as it adds the cost of capacity expansion to its foundry price to cope with customer demand.

Table 2: Key factors affecting Taiwan's wafer foundry industry in 4Q20 and 1Q21 (supply)

Factor	Item	Influence on revenues	
		4Q20	1Q21
Supply	The Taiwan-based foundries continue to expand 8-inch and 12-inch wafer capacity to keep up with strong demand.	↑★★	↑★
	The Taiwan-based foundries' capacity utilization will fall slightly in first-quarter 2021 compared to the prior quarter.	↑★★	↓★
	Foundry prices for 8-inch and 12-inch wafers are on the rise.	↑★	↑★

Note: The more stars, the higher the influence. ↓ indicates negative influence, ↑ indicates a positive influence.

Source: Digitimes Research, February 2021

Demand and supply: 2021

Digitimes Research expects the Taiwan-based foundries to show revenues growth in 2021 thanks to strong demand-side and supply-side factors.

COVID-19 uncertainties continue to drive the semiconductor supply chain to ramp up orders while spurring digital transformation needs.

New 5G smartphone AP and HPC chips being launched will buoy the Taiwan-based foundries' 2021 shipments.

The new chips include Apple's A15 and M series processors, MediaTek's 5G AP, as well as AMD's Zen 4-based CPUs and GPUs.

The trend that IDM customers outsource chip production to the Taiwan-based foundries remains unchanged and their demand is expected to increase.

The Taiwan-based foundries plan to further expand 8-inch and 12-inch wafer capacity while raising prices in consideration of customer demand.

There are some uncertainties that Digitimes Research would like to point out:

According to the IMF forecast released in January 2021, thanks to widespread COVID-19 vaccines and government fiscal stimulus packages, the global economy will grow 5.5% this year, an upgrade from the 5.2% expansion projected earlier.

However, the containment of COVID-19 hinges on how effective the vaccines are against new variants.

The Taiwan-based foundries plan to give priority to urgent automotive chip orders, which however may interfere with the production schedule of 28nm and more mature processes.

The demand from and prices of automotive semiconductor are generally not as high as those of consumer electronics chips. If their production affects shipments of consumer electronics chips, it may negatively impact the Taiwan-based foundries' revenues.

Table 3: Key factors affecting Taiwan's wafer foundry industry in 1H21 and 2H21 (demand and supply)

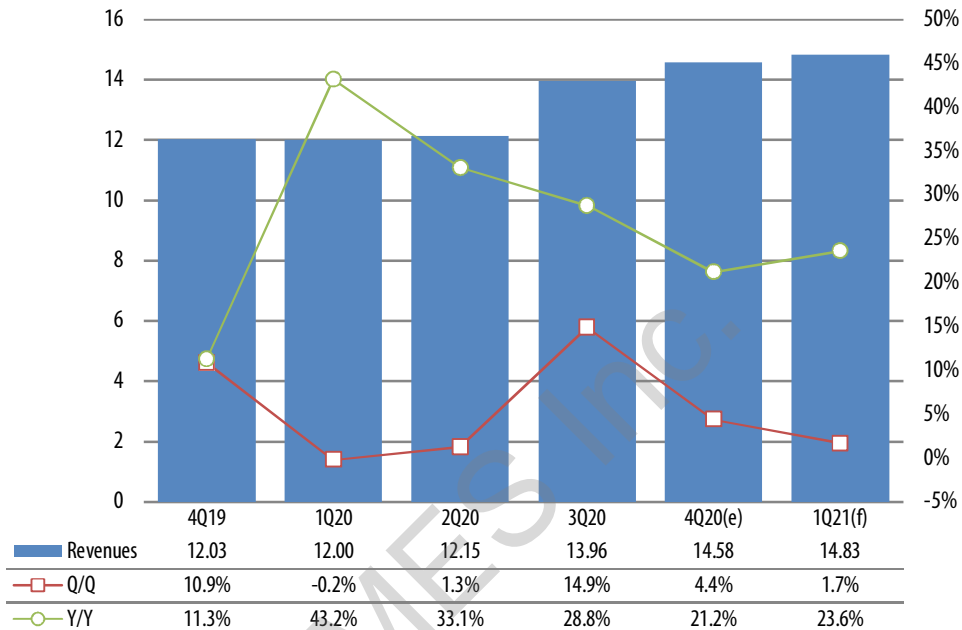
Factor	Item	Influence on revenues	
		1H21	2H21
Demand	The supply chain maintains a high chip inventory level in view of COVID-19 uncertainties.	↑★★★★	↑★★★
	New 5G smartphone AP and HPC chips enter the market.	↑★★★	↑★★★★
	The trend that IDM customers outsource chip production remains unchanged.	↑★★★	↑★★★
	Governments of several countries have requested the Taiwan-based foundries to support the production of automotive chips, contributing to shipment growth.	↑★	↑★
	Semiconductor demand continues to grow, driven by WFH needs arising from the ongoing pandemic.	↑★	-
	COVID-19 uncertainties may weaken global economic recovery.	-	-
Supply	The Taiwan-based foundries increased their capital expenditure for 2021 to add 8-inch and 12-inch wafer capacity.	↑★	↑★★
	Amid strong customer demand, the Taiwan-based foundries are raising their prices.	↑★★	↑★★
	Urgent orders for automotive chips may affect the production schedule of consumer electronics chips.	-	↓★

Note: The more stars, the higher the influence. ↓ indicates negative influence, ↑ indicates a positive influence.

Source: Digitimes Research, February 2021

Taiwan wafer foundry industry

Chart 1: Taiwan key wafer foundry revenues, 4Q19-1Q21 (US\$b)



*Note: Taiwan's key wafer foundries are TSMC, UMC and VIS

Source: Digitimes Research, February 2021

The leading Taiwan-based foundries generated an aggregated total revenues of US\$14.58 billion in fourth-quarter 2020, up 4.4% quarter-over-quarter, to reach a new high in history.

Digitimes Research's original forecast was US\$ 14.47 billion, a 3.6% quarter-over-quarter growth.

Aside from digital transformation needs spurred by COVID-19 and the supply chain's active efforts to ramp up orders, UMC and VIS raising their foundry prices also led to the better-than-expected revenues performance.

Digitimes Research estimates the leading Taiwan-based foundries' total first-quarter 2021 revenues will set the record once again, showing robust performance despite the low season.

Their first-quarter 2021 revenues are estimated to come to US\$14.83 billion, up 1.7% from the prior quarter and 23.6% from the prior year.

The consumer electronics supply chain will continue to ramp up orders to secure foundry capacity.

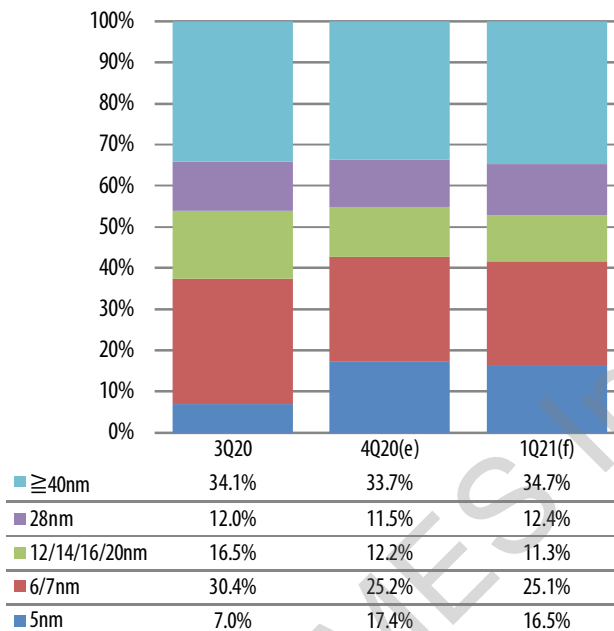
The chips used in consumer electronics include smartphone AP, CPU, GPU, power management IC (PMIC), display driver IC (DDI) and audio codec IC.

The recovering automotive market is driving the demand for automotive semiconductor including MCU, CIS, MEMS, discrete devices, PMIC and DDI.

UMC plans to hike its 12-inch wafer price while VIS is set to increase its 8-inch wafer price again.

Revenues by manufacturing node

Chart 2: Revenue share by manufacturing node, 3Q20-1Q21



*Note: Advanced manufacturing processes are nodes of 28nm and below.

Source: Digitimes Research, February 2021

Based on Digitimes Research estimates, the share of revenues from sub-28nm nodes will fall 1pp in first-quarter 2021.

Due to seasonal influences, the revenues from the 5nm and 16nm nodes will decline moderately from the fourth-quarter 2020 level.

Buoyed by increasing new Apple iPhone shipments, the share of revenues from the 5nm node climbed about 10pps in fourth-quarter 2020 from the prior quarter. Seasonal product adjustment will result in a slight sequential decrease in first-quarter 2021 chip shipments.

The revenues from 16/12nm nodes are estimated to show a sequential decline in first-quarter 2021 with seasonal factors affecting 4G smartphone AP and Wi-Fi module shipments.

The share of revenues from the 7/6nm nodes will edge downward 0.1pp but the revenues will increase.

The shipments of 6nm chips continue to grow fourth-quarter 2020 through first-quarter 2021 thanks to the boost from Unisoc's and MediaTek's 5G AP shipments.

The shipments of 7nm chips are expected to continue expanding in first-quarter 2021 with MediaTek's and Qualcomm's 5G AP as well as AMD's Zen3-based CPU and GPU entering the market.

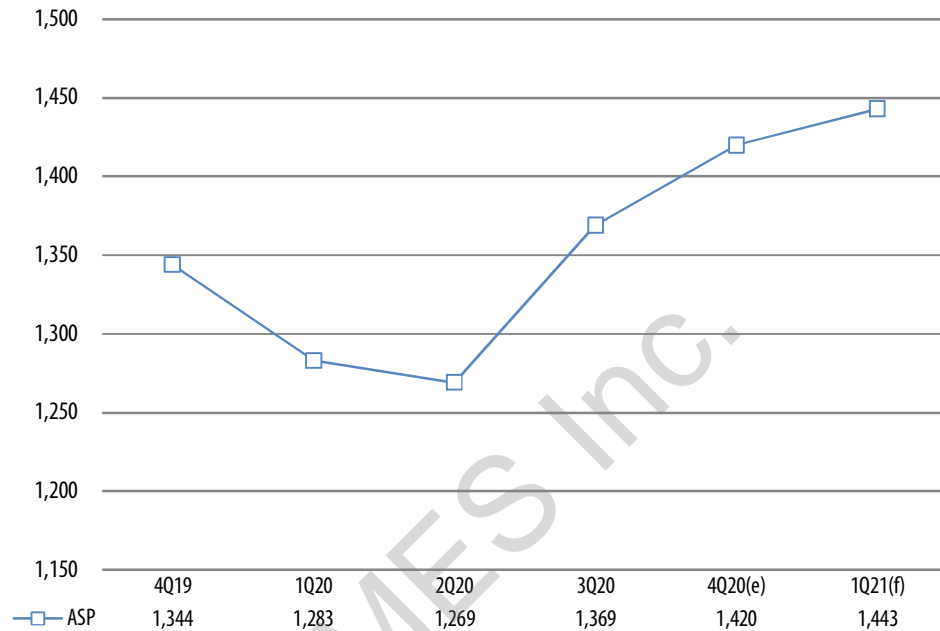
Strong demand from IDM customers and for smartphone OLED DDI will buoy the share of revenues from the 28nm node up 1pp.

According to Digitimes Research's analysis, the share of revenues from 40nm and more mature processes will slightly increase in first-quarter 2021 from the prior quarter as the foundries hike their prices and run at full capacity to meet the strong demand.

UMC and VIS will moderately raise their 8-inch wafer prices in consideration of customer demand.

ASP

Chart 3: Taiwan wafer ASP, 4Q19-1Q21 (US\$/8-inch wafer)



Source: Digitimes Research, February 2021

The Taiwan-based foundries continue to enhance their product mix, pushing their average selling price (ASP) to a new high in fourth-quarter 2020.

Growing shipments of 7nm/5nm chips buoyed the share of revenues from 7nm/5nm nodes.

Rapidly rebounding 28nm process demand drove shipment growth and increase in the share of revenues from the 28nm node.

UMC and VIS raising their 8-inch wafer prices buoyed 8-inch wafer ASP.

Digitimes Research expects the Taiwan-based foundries' ASP to climb to a new high again in first-quarter 2021.

Some foundries will further hike their 8-inch and 12-inch wafer prices, buoying the Taiwan-based foundries' ASP higher.

Their product mix will keep improving, which will drive their APS higher as well.

Some orders, for example, smartphone PMICs, will be produced in 12-inch wafers instead of 8-inch wafers.

Some products originally made on more mature nodes are being migrated to more advanced processes.

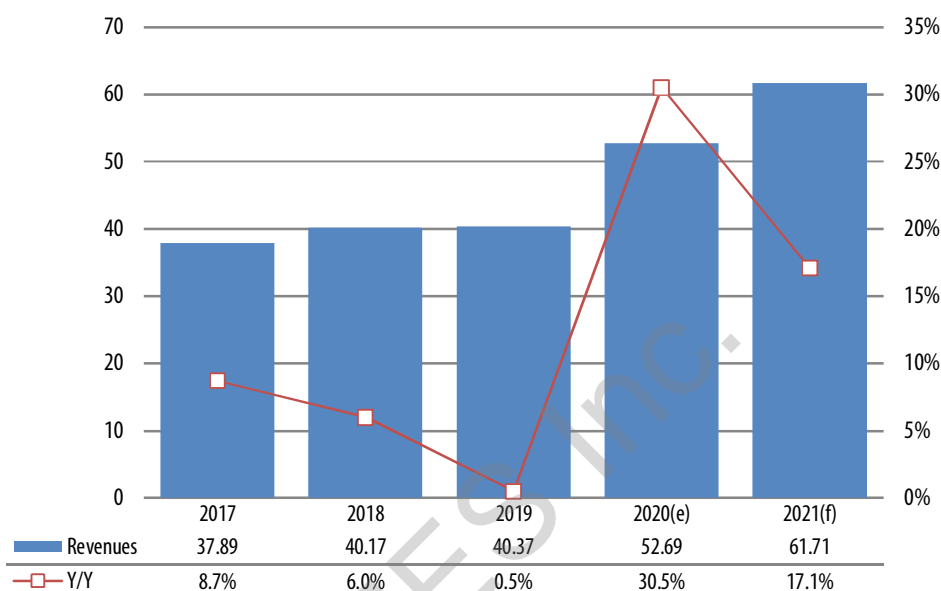
For example, OLED DDI production will migrate from the 40nm node to the 28nm node.

Products made on the 0.5-um/0.35-um/0.25-um processes will migrate to sub 0.18-um nodes.

The revenues from 28nm, 7nm and 6nm nodes continue to grow.

Annual revenues

Chart 4: Taiwan key wafer foundry annual revenues, 2017-2021 (US\$b)



**Note: Taiwan's key wafer foundries are TSMC, UMC and VIS*

Source: Digitimes Research, February 2021

The Taiwan-based foundries generated aggregated total revenues of US\$52.69 billion in 2020, up 30.5% year-over-year, slightly better than Digitimes Research's forecast.

Digitimes Research's forecast was US\$52.58 billion, up 30.2% year-over-year.

Strong shipments of new Apple 5G phones as well as AMD's CPU and GPU buoyed the Taiwan-based foundries' 2020 revenues.

Digitimes Research estimates that the Taiwan-based foundries will generate aggregated total revenues of US\$61.7 billion, up 17.1% year-over-year. The forecast is adjusted upward from that given in fourth-quarter 2020.

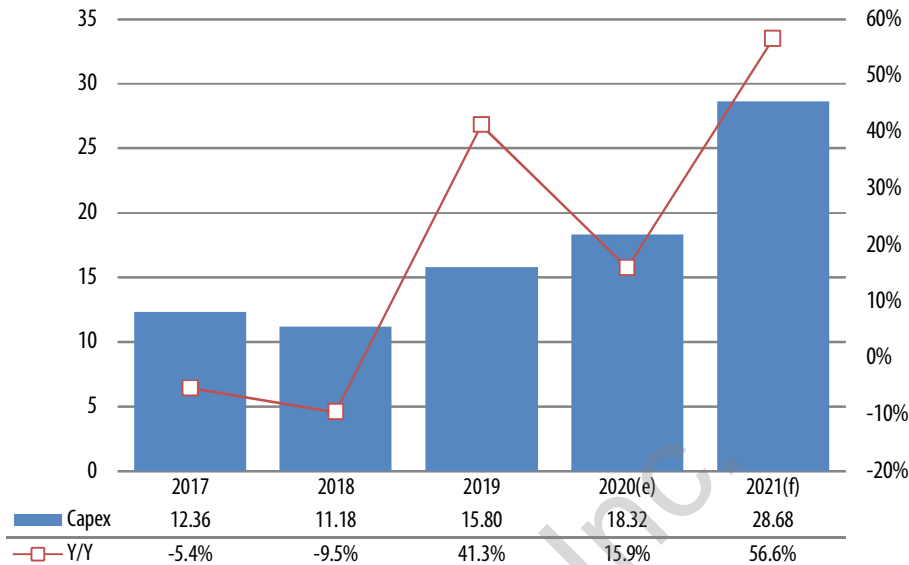
The forecast that Digitimes Research gave in fourth-quarter 2020 was US\$57.1 billion, up 8.6% year-over-year.

The increase in revenues will be a result of the semiconductor supply chain continuing to ramp up orders amid COVID-19 uncertainties and the rebounding automotive semiconductor demand aggravating the global chip shortage.

UMC and VIS are set to raise their foundry prices again in 2021.

The leading Taiwan-based foundries have all increased their capital expenditure for 2021 to keep expanding their capacity.

TSMC, UMC and VIS migrating the production of their customers' products to more advanced processes will fuel their revenues growth.

Chart 5: Taiwan key wafer foundry capex, 2017-2021 (US\$b)

*Note: Taiwan's key wafer foundries are TSMC, UMC and VIS

Source: Digitimes Research, February 2021

According to Digitimes Research's statistics, the leading Taiwan-based foundries' total capital expenditure for 2020 amounted to US\$18.3 billion, a new high in history.

TSMC's capital expenditure came to US\$17.2 billion, UMC's US\$960 million and VIS' US\$120 million.

Their capacity expansion plan is not set back by COVID-19.

Digitimes Research estimates that the leading Taiwan-based foundries' total capital expenditure for 2021 will reach US\$28 billion, soaring nearly 50% from a year ago.

TSMC's 2021 capital expenditure is expected to be US\$25 billion to US\$28 billion, growing 45% to 63% from the prior year.

It will allocate 80% of its capital expenditure for 7nm/5nm/3nm capacity build-up, 10% for advanced packaging and 10% for special-purpose processes.

This includes the capital expenditure required for its new 5nm fab in Arizona and capacity expansion at its Nanjing plant.

According to TSMC, EUV equipment takes tremendous time to assemble and only a limited quantity of equipment is produced every year so it needs to allocate capital expenditure in advance for future capacity planning.

UMC's 2021 capital expenditure is expected to come to US\$1.5 billion, up 57% from a year ago. Its focus will be on expanding 28nm capacity.

USCXM has plans to increase its capacity to 25,000 12-inch wafers per month in first-half 2021. UMC's Tainan plant will continue to add 28nm capacity.

VIS' 2021 capital expenditure is expected to reach US\$180 million, up 47% from a year ago. Its focus will be on expanding the capacity of sub 0.18um nodes.