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EE Times

Taiwan Already Has 3-nm Chips; Why the U.S. Lags

By **Pablo Valerio** 01.09.2023 0

"Apple designs in-house the ultra-complex processors that run an iPhone's operating system. But the Cupertino, California, colossus can't manufacture these chips. Nor can any company in the United States, Europe, Japan, or China. […] they can only be manufactured by a single company in a single building, the most expensive factory in human history…" ***Chip War: The Fight for the World's Most Critical Technology*** *by Chris Miller.*

The nearly 3-year-long global chip shortage has increased the West's appetite for domestically-made chips. Unfortunately, it will be years before either region will produce chips on par with those made in Taiwan.

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Until recently, most western governments, including the European Union and the United States, were not concerned about the supply chain of semiconductors. They knew chips were coming from somewhere, and as long as the end products, such as appliances and vehicles, were manufactured locally, they were not worried about it. But the Covid-19 disruption, combined with the global chip shortage, made the risk of sourcing foreign-made chips painfully clear. The U.S. **auto industry** lost billions of dollars in production as factories sat waiting for semiconductors.

Last year, both the **United States** and the **European Union** enacted new legislation, the so-called CHIPS acts, to foster investment in semiconductor manufacturing in both regions. Companies such as Intel, AMD, and SkyWater have committed to spending hundreds of billions of dollars in new manufacturing facilities and fund training programs at several schools and universities.

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However, those new facilities will take several years to become operational, and, at that time, they will continue to lag behind the most advanced manufacturing technologies. The good news is that the factories will alleviate several industries' current shortage of critical chips.

Meanwhile, Asian governments in Taiwan, South Korea, and Japan have facilitated their way into the silicon industry by subsidizing companies, funding training programs, keeping their currencies cheap, and raising tariffs on imported semiconductors.

TSMC New Factory 18th in Taiwan. (Source: TSMC press)

Over a year ago, then-Arm CEO Simon Segars said that the chip industry is **spending $2 billion per week** to build more capacity and infrastructure. Still, it will take years to shorten delivery times to 2019 levels.

Taiwan continues to lead the way

The semiconductor industry produced more than 1 trillion chips in 2022. The findings of the **Chips Survey**, launched by the European Commission, highlighted that the industry expects demand for chips to double by 2030.

According to industry analysts and the **Semiconductor Industry Association**, Taiwan accounts for about 22 percent of total chip production and more than 90 percent of the most advanced chips worldwide.

Six months ago, C.C. Wei, CEO of Taiwan Semiconductor Manufacturing Co (TSMC), said that the company had issues with manufacturing-tool deliveries for the production of 3-nanometer chips, which could be resolved by the end of the year. Two weeks ago, the semiconductor giant

disclosed that they are already manufacturing using the technology. Analysts expect the new 3-nm technology to create end products with a market value of $1.5 trillion within five years.

"TSMC is maintaining its technology leadership while investing significantly in Taiwan, continuing to invest and prosper with the environment," said TSMC Chairman Mark Liu during the new **factory opening ceremony**.

By 2025, factories in Taiwan will probably start supplying Apple with 2-nanometer chips, **said Handel Jones**, CEO of International Business Strategies.

U.S. companies **led chip production for decades**. But, as countries such as Taiwan and South Korea became proficient in semiconductor manufacturing and their governments provided incentives, the U.S. share of the global chip capacity diminished to around 12 percent nowadays. In the past 10 years, semiconductor production has grown five times faster overseas than in the United States.

Part of the problem is that just two companies, TSMC and Samsung Electronics, can produce the industry's most cutting-edge chips because of the high costs and technical barriers. Both have ambitious road maps in the coming months.

While both companies are now investing heavily in new manufacturing facilities in Europe, the United States, and Japan, they reserve the most advanced technologies for their home markets.

TSMC workers programming a 3-nm machine. (Source: TSMC press)

Supply chain problems affect chip-making equipment

The Dutch company ASML builds 100 percent of the world's extreme ultraviolet lithography machines, which is critical for manufacturing cutting-edge semiconductors. No other part of the global economy is dependent on a few companies.

Six months ago, an ASML spokesman, **talking to the Wall Street Journal**, said demand for the company's systems outstrips its ability to fulfill orders, which it is trying to address by helping customers get more output from existing tooling and other measures.

Interestingly, the shortage of chip-manufacturing equipment is primarily due to the scarcity of less-advanced chips. Machines are increasingly arriving later than expected, and lead times on new orders have stretched to, in some cases, two or three years.

TSMC, among other manufacturers, is warning customers that they might not be able to increase production in the next two years because of a shortage of manufacturing equipment.

Taiwan wants to keep its "Silicon Shield" intact

On November 29, 2022, USS Chancellorsville (CG 62) **asserted navigational rights** and freedoms in the South China Sea near the Spratly Islands, consistent with international law.

"U.S. forces **operate in the South China Sea on a daily basis**, as they have for more than a century. They routinely operate in close coordination with like-minded allies and partners who share our commitment to uphold a free and open international order that promotes security and prosperity." U.S. Navy ships regularly monitor the South China waters, around ten times a year.

Obviously, China is not happy with the U.S. involvement and protection of Taiwan. In 2020, after the U.S. guided-missile **destroyer USS Mustin sailed through the narrow and sensitive Taiwan Strait**, China's military said the latest U.S. navy sailing near Taiwan was "extremely dangerous" and stirring up such trouble was in neither country's interests.

"Beijing has never abandoned its ambitions toward Taiwan. But after years of double-digit investment in the Chinese military and expansionist behavior across the Taiwan Strait and in surrounding maritime areas, Beijing is replacing its commitment to a peaceful resolution with an increasingly aggressive posture," said Tsai Ing-wen, President of Taiwan in an **article in Foreign Affairs** in November 2021.

"Our semiconductor industry is especially significant: a 'silicon shield' that allows Taiwan to protect itself and others from aggressive attempts by authoritarian regimes to disrupt global supply chains. We are working to further strengthen our role in securing global supply chains with a new regional high-end production hub initiative, which will solidify our position in the global supply chain."

To maintain the "Silicon Shield," the Taiwan government continues encouraging companies such as TSMC to keep the latest technology on the island. That's why the new factories the company is opening elsewhere will lag several years in producing the latest chips.

USS Chancellorsville (CG 62) conducting operations in the South China Sea (Source: US Navy Press Office)

In 2020, TSMC initially set the technology level at the new U.S. site in Phoenix at five nanometers. That was an advance over most chips at the time but way behind the level that TSMC produced in Taiwan in 2021. The new plan would upgrade the Phoenix factory to 4-nm technology, which Apple uses now. The second factory, expected to begin operating in 2026, will be able to produce the 3-nm chips, three years behind the technology already in use in Taiwan.

"TSMC is maintaining its technology leadership while investing significantly in Taiwan, continuing to invest and prosper with the environment. This 3nm Volume Production and Capacity Expansion Ceremony demonstrates that we are taking concrete action to develop advanced technology and expand capacity in Taiwan," TSMC Chairman Dr. Mark Liu **said at the ceremony**.

"A new Taiwan Strait crisis would be far more dangerous than the crises of the 1950s. […] But rather than a standoff over an impoverished island, this time the battleground would be the beating

heart of the digital world." concludes Chip War's author Chris Miller.

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Pablo is a seasoned engineer with 30+ years of experience. For over 10 years, he's been a contributing editor for EE Times (where he edits the Supply Chain section). He also wrote for EPSNews, InformationWeek, EBN, LightReading, Network Computing, and IEEE Xplore. His coverage spans Supply Chain, Semiconductors, Networks, IoT, Security, and Smart Cities. He holds an MEng, Electrical and Electronics Engineering from The Ohio State University. **Follow Pablo on LinkedIn**

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