

US-China Chip War Continues. Geopolitics and the Semiconductor Industry

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Global Research, August 09, 2022

[Peoples Democracy](#) 7 August 2022

Region: [Asia](#), [USA](#)

Theme: [Global Economy](#)

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As the tension between the US and China mounts as a fall-out of Nancy Pelosi’s provocative Taiwan visit, the technology war between the two is also taking a new turn. Both houses in the US Congress have approved a \$280 billion plan – The Chips and Science Act – to boost US chip manufacturing. Currently, 75 per cent of chip manufacturing in the world takes place in East Asia, centred around Taiwan, South Korea and China. The US aims to re-shore the semiconductor industry back to the US. It also hopes to revive the fortunes of its chip manufacturers like Intel, once upon a time the king of chip manufacturing, currently fighting not to become another has-been like IBM.

While the plan offers various carrots to the semiconductor industry in the US, termed by some as “corporate handouts”, it also comes with some substantial stick. Any company availing of its \$52.7 billion subsidies for locating computer chip manufacturing in the US is prohibited from expanding or upgrading their advanced chipmaking facilities in China. As a result, companies like Samsung and SK Hynix, two major chip manufacturers who have made substantial investments in China, will now have to choose between walking away from these investments or not availing of the US subsidies.

Meanwhile, China has also not been sitting on its hands, waiting for the US to ratchet up its sanctions on its high-tech ambitions in this area. Recognising that the semiconductor industry, particularly advanced chipmaking, is a key area of struggle, it has made a major advance in manufacturing. SMIC, the Shanghai-based chip manufacturer, released its 7nm chips, which have been in the market for the last 12 months. Currently, only Taiwan’s TSMC and South Korea’s Samsung have succeeded in manufacturing 7nm chips. Dylan Patel, a leading tech analyst, has written, “China’s SMIC is shipping a foundry process with commercially available chips in the open market *which are more advanced than any American or European company...*The most advanced American or European foundry produced chips are based on GlobalFoundries 12nm.” SMIC is the world’s fifth largest chip manufacturer.

The astonishing progress in computational power of electronic chips comes from our ability to pack more and more components into a silicon chip. This is known as Moore's Law and has continued for the last five decades. A measure of the increased density of components in chips is the size of the transistors being created within the silicon chip. Therefore 14nm, 7nm, and 5nm are an indication of the size of the components in the chip and a measure of its computing power.

Lithography is a critical process in chipmaking and is used to create patterns on silicon wafers using ultraviolet (UV) light. The thinner the line that the lithographic machine creates on the silicon wafer, the more the devices that can be packed into a chip. Each of the measures, 14nm, 7nm, 5nm, etc., is a measure of the density of devices on the chip. The more devices we pack into a chip, the more its computing power and its power consumption.

I have written earlier in these columns about chip manufacturing and the importance of tools, specifically the Extreme Ultraviolet Lithography (EUV) machines from ASML, the requisite for moving beyond the 14nm chips. It is not that older Deep Ultraviolet Lithography (DUV) machines cannot create higher densities. But the productivity of DUV machines to produce 10nm or 7nm chips is lower than with EUV technology. And going to 5nm or 3nm is not possible without EUV lithography.

ASML of Netherlands is the only maker of EUV machines in the world. As ASML's EUV machine light source that creates the chip patterns is made by an American company, technically, it comes under US regulations. Though ASML was quite unhappy to lose a part of its China market, it has accepted that it will not supply EUV machines to China. For now, it can still continue to supply DUV machines to China, but this may also change in the future.

The US had believed that without EUV lithographic machines, the Chinese manufacturers would not be able to produce chips below 14nm. The SMIC 7nm chip has therefore blown a big hole in this assumption.

While DUV lithographic tools can create a high degree of packing of devices on a chip, it requires many more runs and a more complex set of operations to achieve such results. This is how lithographic machines for creating 28nm chips could produce 14 nm chips. This is the same process Intel and others have been trying for some time: use DUV technology to create 10nm or 7nm chips. SMIC is the first to successfully use DUV machines for creating 7nm chips.

It still does not put SMIC in the same bracket as Taiwan's TSMC or South Korea's Samsung, which already use EUV technology. But it still puts SMIC ahead of the rest of the pack. It also allows China to compete with products in the market using 7nm chips, as hundreds of its leading companies have come under US sanctions, including Huawei and SMIC. The US interpretation of its powers is that if any company uses US technology, under the US Foreign Direct Product Rule, it must obey the US sanctions regime. That is why ASML's machines are under the US sanctions regime; as also any product manufactured using such machines. Therefore TSMC or Samsung, who use EUV machines from ASML, also cannot export any of their advanced chips to entities in China under the US sanctions regime.

There has been criticism that the 7nm chip from SMIC is only a copy of the TSMC chip and therefore does not show any major advance. While it is indeed a simple chip meant for

cryptocurrency mining, according to *TechInsights*, its importance is that it is a stepping stone for “achieving a “true 7nm process”.

On the flip side is that China cannot go to 5 or 3nm technology without EUV lithographic machines. Currently, it is able to import DUV machines from ASML. Apart from ASML, two Japanese companies, Canon and Nikon, also manufacture DUV machines. So, where is China in manufacturing lithographic machines?

China has built indigenous capability in manufacturing chip manufacturing machines for some time, with Shanghai Micro Electronics Equipment – or SMEE – as its leading manufacturer. SMEE had announced that it would release its first 28nm DUV machine in 2022, which can be used for 14nm chip manufacture. As SMIC has shown, it can then be used for also manufacturing 7nm chips. There is still no announcement from SMEE’s DUV machine of a supply date, which would be crucial for China’s ability to set up large-scale chip manufacturing indigenously.

The world’s semiconductor industry is clearly at a crossroads with the risk of the global supply chain splitting into two competing blocks, one led by the US and the other by China. The US semiconductor industry had argued that if such a split happens, then the US, which has a commanding lead in a number of technology areas today, will lose this lead in 5-10 years as a huge part of its profits and, therefore, R&D investments, are financed from their Chinese sales. Losing that market will mean that China will face a temporary setback but the US will permanently lose its leadership. This is why ASML’s CEO Peter Wennink has said the export restrictions regime that the US is forcing on the industry would not work.

The bulk of the chip market is not for the more advanced chips. According to a report published by the Boston Consulting Group/Semiconductor Industry Association (BCG/SIA) in late 2020, chips less than 10nm density are only 2 per cent of the market, even though they are the most glamorous and figure in the latest laptops and mobile phones. The bulk of the market is in chips for which China already has the technology or can play catch up with its investments in research and in building the entire supply chain, including chip fabrication and even DUV machines. According to the BCG/ SIA report, the smart way for the west to “combat” China would be to restrict the sanctions to only military tech and, from the profits from the rest, finance the R&D expenditure of the US companies. Without these profits, US companies will not be able to finance their future development.

But with “politics in command” in the US and a bi-partisan war hysteria being whipped up, the US seems to prefer the carrot and stick approach: carrot for investing in chip manufacture in the US; and the stick for any company setting up production in China. If the Covid-19 pandemic damaged the semiconductor supply chain leading to a chip shortage in 2021, the supply chain shock in the future is going to be from the US sanctions regime. The belief that the US can restrict the trade war only to sectors where they have a technical edge is the other weakness of the US strategy. It leaves open the possibility of asymmetric responses from China. “May you live in interesting times” is supposedly a traditional Chinese curse. The world appears to be entering such a phase, starting with the US-China chip war.

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