

# THE SINO-AMERICAN SEMICONDUCTOR WAR

## IS IT GAME OVER?

*The article describes one critical ongoing battle in the economic war between the United States and China: the fight for hegemony over the global supply chain and market for semiconductors. The US government, stung by the rising profile of China in the area, is implementing a multipronged strategy of allying with other leading manufacturing countries to deny access to technology and production machinery to the People's Republic of China (PRC); the latter is fighting back by striving to achieve indigenous autonomy in this area while keeping prices below the competition.*

ALEX WANG

**S**emiconductors (chipsets) are the oil of the modern era. We find them everywhere, from smartphones and computers to electric vehicles and from washing machines to telecom network equipment. For all the major industrial powers, acquiring a mastery of chip technology is a strategic priority. It is about technological independence, security of supply, industrial resilience and national sovereignty. *(A chipset or chipset is a set of electronic components included in a pre-programmed integrated circuit, making it possible to manage digital data flows between the processor(s), memory and peripherals. It is found in electronic devices such as microcomputers, video game consoles, mobile phones, digital cameras, etc. (<https://fr.wikipedia.org/wiki/Chipset>))*

The United States is the undisputed leader for the design and the control of manufacturing tools. On the other hand, the production is concentrated in East Asia, particularly in South Korea, Taiwan and since a few years in China, which has greatly worried the Americans.

It is no exaggeration to say that the competition in this area between the US and China is one of the most important areas of tension between the two states.

The Sino-American semiconductor (chipset) war, which started in 2018 with the US targeting Huawei, has now entered a new phase. Both sides have implemented different strategies; however, it is still too early to tell who will emerge as the winner of this war.

#### AMERICAN STRATEGY

The American strategy can be summarised in three parts: 1) embargo; 2) industrial policy; 3) alliances.

#### *Embargo*

From the beginning, the US has focused its efforts on sanctions aimed at the sale of high-end chipsets, 7nm (nanometre) and below, as well as that of lithography machines capable of manufacturing them.

Deprived of chipsets from 14 nm to 7 nm, Huawei has practically disappeared from the high-end smartphone market. The production of 5G equipment has also been impacted.

In addition to Huawei, the Biden Administration is also stepping up successive attacks on the Chinese semiconductor industry.

The Dutch company ASML has been banned from selling the most sophisticated EUV (Extreme Ultra Violet) lithography machines to the Chinese. These machines are essential for making the most advanced chipsets in the world. *(ASML is one of the world's leading manufacturers of photolithography machines for the semiconductor industry. ASML was created in 1984 and based in Veldhoven in the Netherlands. (<https://en.wikipedia.org/wiki/ASML>))* The US would also like to apply the same line of action to DUV (Deep Ultra Violet) machines in view of the increasingly important role they play in China for the manufacture of mid-range chips.

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A further ban is on the cards. This one is about Electronic Design Automation (EDA). Thus the US wants to tighten its grip around China's neck throughout the value chain of chipsets: design, manufacturing and packaging. (*Max A Cherney, Protocol Enterprise, 2 August 2022*)

### ***Industrial policy***

After much delay, 28th July 2022 saw the birth of the Chips & Science Act with a budget of US\$ 280 billion, including US\$ 52 billion to subsidise companies including South Korean and Taiwanese ones which would agree to establish their factories on American soil, provided that they stop their investment in China within the next ten years. US\$ 170 billion would then be spent on technological R&D. (*New Chips Act Could Become a \$280 Billion Boondoggle, Bloomberg, 1 August 2022*)

It looks like a copy of "Made in China 2025". With this industrial aid policy, free capitalist competition here gives way to state capitalism in this area. Uncle Sam saw the need to adapt.

### ***Alliances***

Aware that on its own, it would be very difficult if not impossible for the US to drive China out of the semiconductor supply chain, the Americans are, therefore, actively organising the Chip 4 Alliance with a US\$ 52-billion grant authorised by the Chips & Science Act. Their goal is to rebuild the chip supply chain on American soil, particularly in terms of manufacturing, securing its position as the undisputed leader in the global semiconductor supply chain.

The invited partners are:

- US: Applied Materials, Micron, Intel, Brodcom, Qualcomm
- South Korea: Samsung, SK Hynix
- Japan: Toshiba, TEL, Renesas
- Taiwan: TSMC, MediaTek, ASE Group

The first working meetings took place at the end of August. We could very quickly see signs of the outcome.

With these highly visible measures, is the US strategy likely to succeed? It is not that simple. China is not used to giving up.

## THE MIDDLE EMPIRE STRIKES BACK

In the face of fierce American attacks, China has reacted quickly by mobilising gigantic technological and financial resources, public and private. It aims to become a self-sufficient country in this area.

*A gigantic investment*

Semiconductors are the fourth best-selling products in the world with a value of US\$ 400 billion in 2020. China has planned to spend US\$1.4 trillion between 2020 and 2025 on advanced technologies, including semiconductors. *(Michael Sinclair, China's attempts of self-sufficiency in the semiconductor supply line, Transport Intelligence, 10 February 2022)* Investment in chipset production equipment grew by 44 per cent in 2021 globally to an all-time high of US\$ 102.6 billion, with China posting an even more impressive 58 per cent, keeping the champion spot for the second consecutive year for this category of expenditure, ahead of South Korea and Taiwan. *(Ridha Loukil, L'Usine Nouvelle, 13 April 2022)*

**The first “frontal” part of the strategy consists of fighting head-on with the US by trying to close as quickly as possible the considerable gap in the manufacture of high-end chips. It is a road strewn with pitfalls and long winded. Experts estimate that it would take at least ten years to see results.**

*State aid without complex*

The Chinese state resolutely helps companies that have links with the government. For example, an Organisation for Economic Co-operation and Development (OECD) study shows that four semiconductor companies of this nature received a loan of US\$4.85 billion at a price lower than the market price between 2014 and 2018. These aids constitute a significant cost advantage. A study by the Boston Consulting Group estimates in a study dated 2020 that the cost of construction and operation for a factory in China is 37 per cent lower

than in the US. (*Michael Sinclair, China's attempts of self-sufficiency in the semiconductor supply line, Transport Intelligence, 10 February 2022*)

## A TWO-PRONGED STRATEGY

The first “frontal” part of the strategy consists in fighting head-on with the US by trying to close as quickly as possible the considerable gap in the manufacture of high-end chips. It is a road strewn with pitfalls and long winded. Experts estimate that it would take at least ten years to see results. It is a front that requires a lot of patience. The main player is SMIC (Semiconductor Manufacturing International Corporation). Efforts are not limited but are concentrated in this direction.

The second so-called “bypass” front aims, while patiently awaiting slow progress on high-end products and when possible, the massive use of mature technologies (such as the DUV or Deep Ultra Violet lithography machine) to manufacture the low- and mid-range (14 nm, 29 nm, 32 nm and beyond) chips in order to quickly meet the huge and ever-growing national and international needs. (*Shunzi, “The Art of War”: bypassing instead of attacking head-on*) These chips can be used for electric vehicles (EVs), digitised production lines, home appliance machines, Internet of Things (IoT), etc. 90 per cent of chips requested fall into this category. (*Semiconductors: technologies and equipment 04 November 2021*) The high-end chips (10 per cent) attract much more attention due to their high profit margins. Their use is relatively limited: computers, smartphones, 5G, sophisticated military weapons.

The objective of this drive is to very quickly increase market share internally and externally by taking advantage of the weakness of American manufacturing and the need for local production in China. The production rate in China is 30 per cent, of which 20 per cent is by the subsidiaries of foreign companies. China has over 7000 chipset-related factories, and these are constantly increasing. This is a major card to implement the market flooding strategy. Competitors from China would withdraw from the market after a while due to high cost and low price. When this would happen, that is to say that the 14 nm and 28 nm chips would be produced massively or even exclusively in China, the US and the rest of the world would in turn become dependent on this new player.

Can this flooding strategy work? We still remember the success of this strategy for display panels, batteries, solar panels and, soon, electric vehicles.

## WHERE IS CHINA NOW?

Let's take a look at facts in hand, starting first with the second front.

***Production growth***

The so-called flood strategy is bearing fruit: last year China produced more than 359 billion chips. (*Park Seong-Hun(lee. hojeong@joongang.co.kr), China turns the table on Korea with low-end chips, Korea Joong Ang Daily*) This is a growth of 33.3 per cent; China's production of microchips by domestic companies and foreign factories in the country has grown twice as much as in 2020, according to the Chinese government. China produced 359.4 billion semiconductors in 2021, 33 per cent more than in 2020, according to figures released on 17 January 2022 by the National Bureau of Statistics. In a significant acceleration since, in 2020 the country has produced 261.3 billion units, that is, 16.2 per cent more than the previous year. (*Source: South China Morning Post(Hong Kong), cité dans Courrier international, publié le 21 janvier 2022 à 06h34*)

The Semiconductor Industry Association informs us that among the 39 new production plants built in 2021, ten are in China as compared to ten in Taiwan, five in South Korea, five in Japan, four in Europe and four in the US. According to Semiconductor Equipment and Material International (SEMI), during 2022–2024, we will see 58 new manufacturing plants emerge from the ground, 31 of which will be Chinese.

Bloomberg published a study by IC Insights which shows that among the 20 fastest growing companies, 19 are Chinese.

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### ***Sales and market share***

According to the Semiconductor Industry Association, sales of Chinese chips are up impressively.

Five years ago, its sales were still at the level of US\$ 13 billion, about 3.8 per cent of global sales. In 2020, China took a big leap forward with an annual growth rate of 30.6 per cent or US\$ 39.8 billion, capturing nine per cent of the global market share by overtaking Taiwan and closing in on Japan and the European Union (EU), each of which has ten per cent

If China maintains an annual growth rate of 30 per cent for the next three years, it would generate in 2024 an income of US\$ 116 billion, thus capturing 17.4 per cent of the world market share. This puts it just behind US and Japan. (*China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's, 10 January 2022, Semiconductor Industry Association*)

In addition to these numbers, let's also look at some highlights. The import of chips by China has reduced by 28.3 billion pieces. This change is mainly due to the adaptation of chips produced locally by Chinese companies. Previously, the latter did not like these local products because of the lower quality and high prices compared to imported products.

Recently, the South Koreans had a big surprise. After 30 years, South Korea recorded for the first time a trade deficit compared to China. Export to its big neighbour amounted to US\$ 13.4 billion in May and import 14.6 of which 16.5 per cent are chips for a value of US\$2.4 billion and with a growth of 40.9 per cent compared to last year's for the same period. Given that it is usually always South Korea that exports more chips to China, this reversal of the trend has shaken up Korea and the chip industry. This shows the speed with which China is executing its flood strategy. (*Park Seong-Hun, ibid*)

### ***Technological progress***

On the high-end chips front, the national mobilisation of technological resources is starting to pay off as well.

We were surprised by the following news: Chinese chip maker SMIC managed to switch to 7nm etching technology, using the DUV lithography machine instead of EUV lithographic systems not available at SMIC due to the US embargo. (*Ridha Loukil, ibid, 2022*) We didn't think it could come so quickly.

This was revealed by the American semiconductor website Tech Insights, which said that SMIC had been producing chips of this size since last year. Tech Insights found them within the ASIC (application-specific integrated circuit) crypto currency-mining machine made by SMIC. *(Dylan Martin China seems to have figured out how to make 7nm chips despite US sanctions, Register, 22 July 2022)* While it is not completely certain that these chips feature the typical bit cell memory, called for in the definition of 7 nm technology, it does demonstrate 7 nm logic, reflecting significant progress in catching up, helping to reduce the gap of two generations and preparing for mass production.

Research on lithographic machines continues unabated, for example at SMEE (Shanghai Micro Electronics Equipment).

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IS IT GAME OVER?

### *The American side*

We see the very visible effects of the American embargo strategy, which tends to widen. The ban on the sale of high-end chips and those of lithographic machines to manufacture them (EUV) have produced spectacular results. Huawei is one of the victims: its high-end smartphones have disappeared from the world market.

The US has neglected the mature technology front. Noting the successes of the circumvention strategy, the US is in the process of forcing ASML to no longer sell to China, in addition to EUV machines, its DUV modules. Considering that China is the most important customer, the Dutch company is putting up a fight against the Americans. ASML is aware that if it leaves the Chinese market, it will never come back because China will embark on a national catch-up campaign, first to satisfy domestic needs then to export quickly and massively to foreign markets with advantages of price. ASML's first-quarter figures show that sales



growth to China, its biggest customer, rose from 22 per cent to 34 per cent. We can understand that ASML does not want to commit suicide.

Among the designated participants, the American companies would like to have the lion's share. The choice is considered to have already been made by the Americans for Japan.

The Chip 4 Alliance is forming under enormous pressure from the US. Japan is already on board; the US has made the choice for the country. Samsung is still dragging its feet. Under sheer compulsion, the Taiwanese TSMC will surely be part of it. Alignment remains difficult because the conditions for receiving the subsidy are draconian: the cessation of all investment in China within the next ten years. Not to mention the inevitable significant cost increase. This portends the loss of competitiveness of future products.

The implementation of the agreement will be long and full of pitfalls. TSMC is starting to taste this plan as a fish full of bones. Construction costs are six times higher in the US, human resources 30 per cent more expensive. The founder and former CEO of TSMC, Mr. Zhang Zhongmou, said very clearly last year that the project was not realistic. (*SMM News, Zhang Zhongmou complained about the US semiconductor subsidy policy: US\$ 50 billion is not enough to build a complete local supply chain, 28 October 2021, Source: Financial Union*)

It is very difficult for him to recruit sufficiently disciplined and resilient American engineers and technicians. Accustomed to comfort, Americans do not accept the arduous working conditions in the chip industry. TSMC is in the process of recruiting and training the necessary personnel in Taiwan to send them to its future factory in Arizona.

They are faced with a dilemma: follow the US in a “political” project that lacks economic rationality or be punished by Uncle Sam.

As a new measure, the US is also considering banning the sale of software intended for the design of chips (EDA: Electronic Design Automation). (*Max A. Cherney, 2022, ibid*) This is a very hard blow for the Chinese.

Another strategic weakness is the slowness with which the US Congress prepares and adopts laws about innovation. Unable to agree, legislators were forced to make a separate case for semiconductors in order to pass a Chips & Science Act. They thus lost two years.

It is foreseeable that the US will do everything to reach its objective. Do they have the means to get there? That is another matter.

### *The Chinese side*

On the Chinese side, we have seen that the flooding strategy is bearing fruit. They are in the process of opening a breach on the field of the high-range products with the 7 nm chips.

China has its challenges too. The amount of investments and the degree of mobilisation are not synonymous with success. Technological mastery requires a lot of time and experience. Moreover, one should be very vigilant about opportunists and profiteers of all kinds who will come, talking of innovation and patriotism, not to contribute to the cause but to fill their pockets. Disorganisation and inefficiency in investing are part of the concern.

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### *Once upon a time ISS*

Started in 1978, the International Space Station (ISS) was meant to be an international cooperation programme. The European Agency, Russia, Germany, Brazil etc. were completely open to accepting China which was eager to be part of it. ([https://en.wikipedia.org/wiki/Politics\\_of\\_the\\_International\\_Space\\_Station#cite\\_note-justice1-52](https://en.wikipedia.org/wiki/Politics_of_the_International_Space_Station#cite_note-justice1-52)) Unfortunately, none of them took into account the resolute and systematic hostility of the Americans who evoked security reasons out of fear that the technologies could be used by China for military purposes.

This attitude was formalised in the so-called Wolf Amendment Law passed in 2011 in the US Congress, according to which the National Aeronautics and Space Administration (NASA) was prohibited from using US Government funds directly or bilaterally in cooperation with the Chinese Government and organisations related to the latter unless authorised by the Federal Bureau of Investigation (FBI) and Congress. Of course, those permissions never came. It is the same music we have heard in the chipset dispute. ([https://en.wikipedia.org/wiki/Wolf\\_Amendment](https://en.wikipedia.org/wiki/Wolf_Amendment))

China was forced to rely on itself to start and successfully complete its manned space station programme TIANGONG (Celestial Palace). The assembly of the 11 parts of the station is underway and progressing as planned. Beyond 2024, this will be the only operational station in the sky. In parallel, the Moon and Mars programmes will also continue.

China has won its bet despite and, in part, thanks to the American ban. It is clear that China is capable of relying on its own resources to develop its space programme despite external pressure. Sanctions help the country to make its own decisions and carry them out methodically.

Could this reasoning be applied to the self-sufficiency of the semiconductor industry? Given what we have seen, we would be tempted to answer in the affirmative, but it is still too early to say because there is a wide gap between the cup and the lips. The Americans still have a few “cards” up their sleeve. They are not going to let go anytime soon.


#### EUROPE: PLANS ONCE AGAIN TO BECOME A WORLD LEADER IN SEMICONDUCTORS

Let's not forget Europe; although today it produces less than ten per cent of the world's microchips, compared to 40 per cent 30 years ago, the continent remains a significant player and is making efforts to come back. *(Maxence Fabrion (@max\_fabrion), Entre l'UE, les États-Unis et la Chine, la guerre des semi-conducteurs a éclaté (Between the EU, the United States and China, the semiconductor war has broken out), Les Numériques, publié le 07 March 2022 à 15h00)*

In Europe's list of priority actions to be taken over the next five years, the strengthening of the chips industry should occupy a central place. The attention and the means are not to be put on the relocation (decoupling) of mature and commonly available products but on the preparation/materialisation of future technological and industrial capacities, including those related to semiconductors. To do this, the appropriate dimension is continental.

It is in this state of mind that the European Commission presented the Chips Act (Semiconductor Plan) budgeted at €43 billion. Europe has remarkable technological capabilities in this area, but the important thing is to produce. “It is therefore imperative to invest in our production capacities both in very large factories (called ‘Mega Fabs’) but also throughout the entire value chain”. *(European Commission, EU Chips Act: Europe's plan to become world leader in semiconductors)* This is to account for 20

per cent of global production by 2030. This is an important initiative on the part of Europe as a collective entity.

Efforts at the level of individual member states are also underway. For example, ST Micro and Global Foundries have agreed to build a €5.7 billion factory in Grenoble, France. Significant financial support from the French State is expected. (*Ouest-France with l'AFP, le 11 July 2022*)  DI2642022SASWAW@6879