

## On the development of Chinese semiconductor industry and its meaning to Japan

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The semiconductor industry in Mainland China has a fast trend. As a pillar of China's manufacturing 2025, support by the government to the semiconductor industry is active, and since the establishment and plan of the semiconductor manufacturing factory and the silicon wafer factory has rapidly increased since the establishment of the China Integrated Circuit Industry Investment fund Co., Ltd. (CICF) in 2014. China has more than four times the gap of domestic supply to semiconductor demand, and the import value of semiconductor exceeds the amount of oil imports. By this economical reason, the government lead investment in semiconductor manufacturing. [1] And it is causing friction with the United States. The US wants to protect the top position of the hierarchical structure of electronic devices (Fig.1). [2] CNBC reports that the US is causing trade friction to take the initiative of 5G against China's positive efforts to China semiconductor industry. [3] The number of establishment of the new manufacturing fab in China (8 inches, 12 inches) is about 30 as far as it can grasp (Table1). In addition, the number of silicon wafer fab as semiconductor materials is around nine. Advanced technology in China is 28 nm behind by 3 generations and is in mass production stage (Table2). Semiconductor development and manufacturing of not only logic but also memory (DRAM, 3DNAND) and power IC are active, and SiC and GaN device factories are planned to be newly established. With respect to the development of the Chinese semiconductor industry like this, in the semiconductor industry in Japan, equipment and materials makers are booming. They have received unexpected orders for demand from the Mainland China and global demand by the Super Silicon Cycle. For example, it takes about 8 months to about a year, which is more than twice as long as ordinary from ordering of equipment to delivery. Semiconductor manufacturing equipment exports from Japan to China are rapidly increasing, reaching 700 billion yen in 2017. Meanwhile, the export of electronic components such as semiconductors from Japan to China has remained flat at about 1 trillion yen since 2006. As for imports from China, communications equipment (such as smartphones) is on the rise of 2.2 trillion yen (2017). The export of electronic parts such as semiconductors to Japan is about 500 billion

yen. In a near future, what is the meaning for Japan if the Chinese semiconductor industry developed successfully as a result of Made in China 2025? In this paper, the development trend of the Chinese semiconductor industry (Made in China2025), the trade friction between China and the United States, and the meaning they give to Japan. And I would like to have some suggestions for thinking about the semiconductor manufacturing industry in Japan.

Comparison was made between the dominance and inferiority of the semiconductor industry competition in 2018 and 2025. In 2025, the inferiority of Chinese memory and semiconductor manufacturing equipment/materials was eliminated, and Japan's inferior CPU / GPU / AI, DRAM, advanced manufacturing remained unchanged in 2018 (Table3). Therefore, in exports and imports, Japan will generate a deficit of more than 3.7 trillion yen in future devices. China will be able to supply its core devices in the future. And the export of advanced semiconductors manufactured in China (and finished products equipped with them, smart phones etc.) to Japan will increase (Fig.2). With innovation 25 raised by the Japanese government, about 60% of future core devices will depend on overseas products (Table4). That is, Japan's competitiveness is weak at 5G, the core of Innovation 25 (or Industry 4.0, Society 5.0), the construction of each infrastructure is delayed, and the value of goods in the world market is low.

Further discussion will be reported at the conference.

[1] FumitakeMieno, World Economic Papers, 2017, Vol.1, P180

[2] Tony Chau and Fumitake Mieno, Journal of Chinese Economy & Management Studies, Vol2, No.1, 2018, P21

[3]<https://www.cnbc.com/2018/07/06/a-major-factor-behind-the-us-china-trade-war-is-winning-in-a-crucia-1-t.html> (20180903)

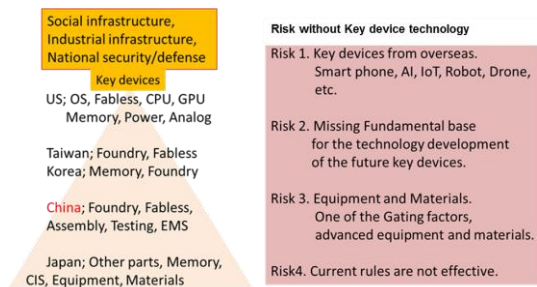


Fig.1. Hierarchical structure of the electronic device industry.

Company	Location	Company Type	Technology
SMIC	Shanghai	Foundry	14/28/40nm
	Beijing	Foundry	28/40/55nm
HLMC	Shanghai	Foundry/IDM	28/40nm
HHG	Wuxi	Foundry	65/90nm
YMTC(XMC)	Wuhan	3DNAND, DRAM	64P/20nm
Jinghe	Hefei	LCD driver	0.11/90nm
Innotron	Hefei	DRAM	19nm
HIDM	Huaian	CIS	
AOS	Chongqing	Power Device	
Intel	Dalian	Xpoint NAND	
TSMC	Nanjing	Foundry	16nm
UMC	Xiamen	Foundry	40/28nm
JHICC	Quanzhou	DRAM	Specialty
GF	Chongqing	Foundry	FDSOI
SiEn	Qingdao	CIDM	40/28/14nm
HSMC	Wuhan	CIDM	12nm
CanSemi	Guangzhou	CIDM	Power IC
GTA	Shanghai	Foundry	
Samsung	Xian	3DNAND	3DNAND
Hynix	Wuxi	DRAM	DRAM

Table1. New Fab plan in mainland China.

12 inch			
Logic	SMIC	28nm	PolySiON, HKMG Production
		14nm	20191H Risk production
NAND	SMIC	24nm	Production
	YMTC	3D64	Development
NOR	SMIC		Production
CIS	SMIC	FSI/BSI	Production
	HLMC	BSI	Production
8 inch			
Power	SMIC		Power Management IC, LCD
	HHG, etc.		OLED driver, SBD, Power MOS, IGBT, etc.
Sensor	SMIC,		CIS, finger print, MEMS, etc.
	ASMC, etc.		
Analog	ASMC, etc.		

Table2. Technology development status in mainland China.

Year	2018		2025	
	Japan	China	Japan	China
Country				
Smart phone	△	◎	△	◎
IC products				
CPU/GPU/AI	×	○	×	◎
NAND Flash	◎	△	◎	○
DRAM	×	△	×	○
CIS	◎	△	◎	○
Power	○	△	○	○
Discrete	△	○	△	○
IC production				
Design	△	○	△	◎
Fab 40nm above	○	○	○	◎
Fab 28nm below	×	○	×	◎
Assembly, testing	○	◎	○	◎
Equipments	◎	△	◎	○
Materials	◎	△	◎	○

Table3. Competitive advantage and disadvantage of Japan and mainland China in the Semiconductor Industry.

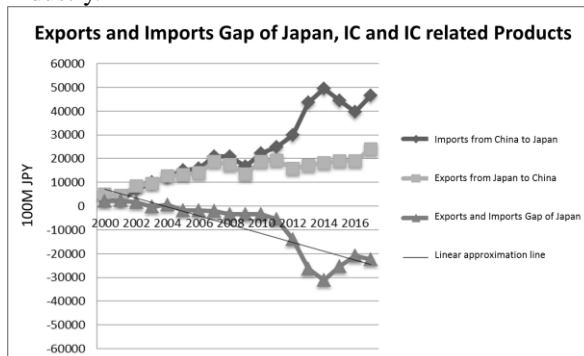


Fig.2. Exports and imports gap of Japan to mainland China, in IC and IC related products.

Devices/System	Purpose	Core ICs	Domestic supply IC	Overseas supply IC	Domestic full supply	2025China supply
Personal display devices	50Inch terminal, smart monitor, meditation	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
103inch display devices	50Inch terminal, Internet, TV, phone, etc.	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Personal Flexible display devices	50Inch terminal, teleworking use, etc.	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Electric car, bus	GPS, 5GNetwork, Automobile	PowerIC/3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/Communication IC/High end	PowerIC/3Dsensor/MEMS/CIS/Flash/MPU	MEMS/CIS/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
ITS (Intelligent Transportation System)	5GNetwork, various infrastructures	3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/MPU/Communication IC	3Dsensor/MEMS/CIS/Flash/Communication IC	CPU/GPU/AI/DRAM	×	○
Educational VR	5GNetwork	CIS/GPU/AI/DRAM/Flash/Communication IC	PowerIC/3Dsensor/MEMS/CIS/Flash	CPU/GPU/AI/DRAM	×	○
Wearable terminal devices	Emergency medical network, emergency security network	PowerIC/3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/MPU/Communication IC/High end	PowerIC/3Dsensor/MEMS/CIS/Flash/MPU	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Advanced automatic translation functional Headphone	5GNetwork, AI, Edge computing	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Home robot	5G network, short distance network	PowerIC/3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/MPU/Communication IC/High end	PowerIC/3Dsensor/MEMS/CIS/Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Robotics network system	5G network, short distance network	PowerIC/3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/MPU/Communication IC/High end	PowerIC/3Dsensor/MEMS/CIS/Flash	CPU/GPU/AI/DRAM/Flash/Communication IC/High end	×	○
Self-propelled carry cart	Short distance network	PowerIC/3Dsensor/MEMS/CIS/GPU/AI/DRAM/Flash/MPU/Communication IC/High end	PowerIC/3Dsensor/MEMS/CIS/Flash/Communication IC	CPU/GPU/AI/DRAM/Flash	×	○
Data center	5GFor each network system, 5G	CPU/GPU/AI/DRAM/Flash/Communication IC	Flash/Communication IC	CPU/GPU/AI/DRAM/Flash/Communication IC	×	○
Sensor network devices	5G network, edge computing	MEMS/CIS/Communication IC	MEMS/CIS/Communication IC	-	○	○
Emergency information system devices	Earthquake automatic detection, secondary detection	MEMS/CIS/Communication IC	MEMS/CIS/Communication IC	-	○	○
Home electric appliances with automatic earthquake detection function	Earthquake automatic detection, secondary detection	MEMS/CIS/MPU/Communication IC	MEMS/CIS/MPU/Communication IC	-	○	○
Road sensor	Sensor network	MEMS/CIS/Communication IC	MEMS/CIS/Communication IC	-	○	○
IC cash card	Accept international standardization	MPU	MPU	-	○	○
Solar power generation system	Japan-China joint venture	PowerIC/Power ManagementIC	PowerIC/Power ManagementIC	-	○	○
Large power transmission line	Superconducting cable	PowerIC/Power ManagementIC	PowerIC/Power ManagementIC	-	○	○
Wall lighting	Automatic adjustment	PowerIC/Power ManagementIC/CIS/Communication IC	PowerIC/Power ManagementIC/CIS/Communication IC	-	○	○

Table4. Core devices of Innovation25 and key ICs, Domestic IC supply possibility.