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-factorbehind-the-us-china-trade-war-is-winning-in-a-crucia l-t.html (20180903)

Social infrastructure, Industrial infrastructure, National security/defense	Risk without Key device technology Risk 1. Key devices from overseas.				
Key devices US; OS, Fabless, CPU, GPU Memory, Power, Analog Taiwan; Foundry, Fabless Korea; Memory, Foundry	Smart phone, AI, IoT, Robot, Drone, etc. Risk 2. Missing Fundamental base for the technology development of the future key devices.				
China; Foundry, Fabless, Assembly, Testing, EMS	Risk 3. Equipment and Materials. One of the Gating factors, advanced equipment and materials.				
Japan; Other parts, Memory, CIS, Equipment, Materials	Risk4. Current rules are not effective.				

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

Company	Location	Company Type	Technology	
SMIC	Shanghai	Foundry	14/28/40nm	
SIVIC	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	Chongging	Power Device		
Intel	Dalian	Xpoint NAND		
TSMC	Nanjing	Foundry	16nm	
UMC	Xiamen	Foundry	40/28nm	
JHICC	Quanzhou	DRAM	Specialty	
GF	Chongqing	Foundry	FDSOI	
SiEn	Qingtao	CIDM	40/28/14nm	
HSMC	Wuhan	CIDM	12nm	
CanSemi	Guangzhou	CIDM	Power IC	
GTA	ShanghaiS	Foundry		
Samsung	Xian	3DNAND	3DNAND	
Hynix	Wuxi	DRAM	DRAM	

Table1. New Fab plan in mainland China.

12 inch					
Logic	33 H G	28nm	PolySiON, HKMG Production		
	SMIC	14nm	20191H Risk production		
	HLMC	28nm	Development		
NAND	SMIC	24nm	Production		
INAND	YMTC	3D64層	Development		
NOR	SMIC		Production		
	SMIC	FSI/BSI	Production		
CIS	HLMC XMC BSI		Production		
8 inch					
	SMIC		Power Management IC, LCD		
Power	HHG,et c.		OLED driver, SBD, Power MOS, IGBT,etc.		
Sensor	SMIC, ASMC,e		CIS, finger print,MEMS, etc.		
Analog	ASMC,e				

Table2. Technology development status in mainland China.

Year	2018		2025	
Country	Japan	China	Japan	China
Smart phone	Δ	O	Δ	Ô
IC products				
CPU/GPU/AI	×	\bigcirc	×	O
NAND Flash	Ô	Δ	O	0
DRAM	×	Δ	×	0
CIS	O	Δ	O	0
Power	0	Δ	0	0
Discrete	Δ	\bigcirc	\triangle	0
IC production				
Design	Δ	\bigcirc	Δ	Ô
Fab 40nm above	0	\bigcirc	\bigcirc	Ô
Fab 28nm below	×	\bigcirc	×	Ô
Assembly, testing	0	Ô	\bigcirc	0
Equipments	0	Δ	O	0
Materials	Ô	Δ	O	Ó

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



Fig.2.	Exports	and	imports	gap	of	Japan	to	main	land
China,	in IC ar	nd IC	related	prod	uct	s.			

Devices/System	Purpose	Core Ica	Domestic supply IC	Overseas supply IC	Domestic full supply	2025China supply
	5GNet tarminal.Health	CPU/GPU/AI/DRA		CPU/GPU/AI/DRAM		
Personal display devices	monitor.	M/Flash/Communica	Flash	/Communication	×	0
	Medication	tion IC(High end)		IC(High end)		
	5GNet terminal	CPU/GPU/AI/DRA		CPU/GPU/AL/DRAM		-
103inch display devices	Internet TV phone etc.	M/Flash/Communica	Flash	/Communication	×	0
		tion IC(High end)		IC(High end)		
Personal Flexible display	5GNet	CPU/GPU/AI/DRA		CPU/GPU/AI/DRAM		-
devices	tarminal,Teleworking use	M/Flash/Communica	Flash	/Communication	×	0
	etc.	tion IC(High end)		IC(High end)		
		PowerIC/3Dsensor/				
	GPS, 5GNetwork	MEMS/CIS/CPU/G	PowerIC/3Dsensor/	MEMS/CIS/CPU/GP		
Electric car, bus	Automobile	PU/AI/DRAM/Flash	MEMS/CIS/Flash/M	U/AJ/DRAM/Commu	×	0
		/ MPU/ Communicati	PU	nication (High end)		
		On A/(High end)				
IT 9 /lekellissek	EONet uner Verieue	C19 /C PUI /O PUI /A1/	3Dsensor/MEMS/CI			
Transportation Sustem)	infrantructure	DDAM/Elash/MDU/	S/Flash/Communica	CPU/GPU/DRAM	×	0
Transporcation System)	Intrastroctore	One of the second second	tion IC			
		2Daenacy/MEMS/				
		C19 (C DU/O DU/A1/	RevealC/2Decessor/			
Educational VR	5GNet work	DRAM/Elash/Comm	MEMS/CIS/Elash	CPU/GPU/AI/DRAM	×	0
		unication 10	MEM 3/ 033/ Fidari			
		ReverIC/3Deepace/				
	Emergency medical	MEM9/C19/CELL/G	ReventC/2Deepeer/	CRU/ORU/A1/RRAM		
Waarable terminal devices	network.	PII/AI/DPAM/Elash	MEMS/CIS/Elash/M	/Communication	×	0
	emergency security	/Communication	PU	IC(High and)		
	network	IC(High end)				
Advanced automatic	FORM AND ALL FRAME	CPU/GPU/AI/DRA		CPU/GPU/AI/DRAM		
translation	SUNET WORKAL Edge	M/Flash/Communica	Flash	/Communication	×	0
functional Headphone	computing	tion IC(High end)		IC(High end)		
		PowerIC/3Dsensor/				
	5G network, short	MEMS/CIS/CPU/G	PowerIC/3Dsensor/	CPU/GPU/AL/DRAM		~
Home robot	distance network	PU/AL/DRAM/Flash	MEMS/CIS/Flash	/ Communication	× 1	U U
		/MPU/Communicati		IU/(High end)		
		on JU(High end)				
		MEMP(CIP (CRUIC)				
Debaties estuaris sustan	5G net work, short	DII/AI/DDAM/Elash	PowerIC/3Dsensor/	Communication	, v	0
NUDUCICS NECHOIX System	distance network	/MDU/Commission	MEMS/CIS/Flash	20/Mahaad)	<u> </u>	
		on 20(High and)		IO(High end)		
		RewarlC/3Deepace/				
		MEMS/CIS/CELL/G	ReventC/2Deepeer/			
Salf-procelled carry cart	Short distance network	RIL/AI/DRAM/Elesh	MEMS/CIS/Elash/C	CPU/GPU/AI/DRAM	×	0
our properties carry care		/MPIL/Communicati	ommunication IC	/Flash		
		on IC				
		CPU/GPU/AI/DRA		CPU/GPU/AI/DRAM		
Data center	SGFor each network	M/Flash/Communica	Flash/Communicatio	/Communication	×	0
	system, 5G	tion IC	n 10	IC(High end)		
Parana and mark deviate	5G network, equipped	MEMS/CIS/Commun	MEMS/CIS/Commun	-		_
Sensor net Work devices	with	ication IC	ication IC	-		
Emergency information	Earthquake automatic	MEMS/CIS/Commun	MEMS/CIS/Commun			
system devices	detection, secondary	ication IC	ication IC	-		
Home electric appliances	Earthquake automatic	MEMS/CIS/MP11/Co	MEMS/CIS/MPU/C			-
with automatic earthquake	detection, secondary	mmunication IC	ommunication IC	-		0
detection function	disaster prevention					
Road sensor	Sensor Network	MEMS/CIS/Commun	MEMS/CIS/Commun	-	0	0
	#1	ication IC	ication IC			-
IC cash card	NUMUCEPT International	MPU	MPU	-	0	0
Calar anna anna tha	standardization,	Bauario (Bauar	Barrad C (Barran			
Solar power generation	o aparr-ohina joint	Management 2	Management IC	-	0	0
Lerre power traper initia	venture	RewardC/Review	RowerIC / Rower			-
carge power transmission	Superconducting cable	Management *	Management ¹⁰	-	0	0
pro-		RowarlC/Rowar	RowardC/Rowar			
Wall Exhting	Automatic adjustment	ManagementIC/CIS/	ManagementIC/CIS/	-		0
ing spring	- according and a second secon	Communication 10	Communication IC			
			1			

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