

Analysis on Current Situation and Countermeasures of Semiconductor Industry Development

-- A Case Study of Hefei City, Anhui Province

Runnan Zhang^{1, a}, Yifan Jia^{1, b}, Yixin Li^{1, c}, Yanyan Tan^{1, d}, Yunjun Lin^{2, e}

¹ School of International Economics and Trade, Anhui University of Finance and Economics, Bengbu 233030, China

² School of Finance and Public Administration, Anhui University of Finance and Economics, Bengbu 233030, China

^a1595258884@qq.com, ^b942390761@qq.com, ^clyx523jiayou@163.com, ^d3385248420@qq.com, ^e2519247356@qq.com

Abstract

As a cutting-edge technology and high value-added industry, semiconductor has gradually developed into a pillar industry of global economic growth. After several years of technology accumulation and achievement stack, Hefei semiconductor industry has formed a large-scale, systematic and diversified industrial layout, but the "bottleneck" and challenges can not be ignored. Based on the current situation and existing problems of Hefei semiconductor industry development, this paper puts forward relevant countermeasures and suggestions to break through the bottleneck and help the industry boosting, in order to give suggestions for the iterative upgrading of Hefei semiconductor industry.

Keywords

Semiconductor Industry; High Quality Development; Risk Identification and Prevention.

1. Development Status of Domestic Semiconductor Equipment Industry

1.1. Overview of the Development of China's Semiconductor Industry

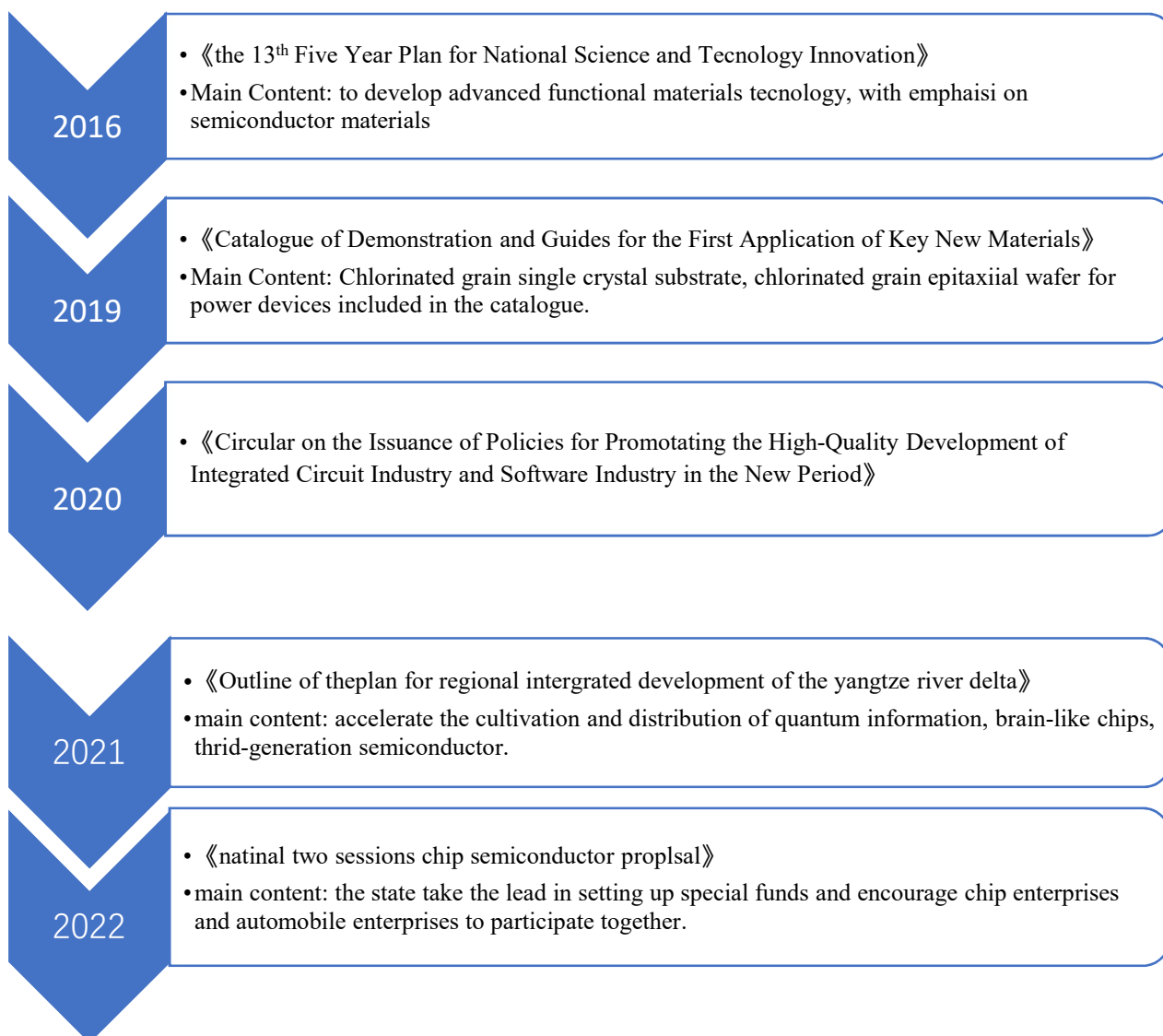
1.1.1. Overview of Domestic Policy Environment

During the 14th Five-Year Plan period, the country paid great attention to the fields of integrated circuits, high-end chips and new-generation semiconductor technology. Check the breakthrough of core technology and the application of new materials. National and provincial key laboratories should be established in colleges and universities around the country, and relevant scientific research funds should be provided to support them, so as to ensure the research and development of sophisticated technologies and the introduction of talents. We will give relevant policy support to semiconductor enterprises, promote the deep integration of enterprises, universities and research institutes, and give full play to the role of local enterprises as innovation subjects. Strengthen the cultivation of semiconductor talents, and create an innovative platform and atmosphere for the semiconductor industry. For China's semiconductor industry development to provide their own power to achieve the transformation from blood supply to hematopoietic.

On March 29, 2021, issued by the Ministry of Finance, General Administration of Customs, administration of taxation on the support the development of the integrated circuit industry and software industry import tax policy notice, namely through the import duties to adjust, enhancement of the import of various products in semiconductor and semiconductor supply

chain, in order to meet the production requirement of semiconductor related enterprises in our country, It mainly includes production raw materials, consumables, and components of integrated circuit production equipment for self-use which cannot be produced or whose performance cannot meet the relevant needs of enterprises producing integrated circuit characteristic processes. Further promote the development of China's semiconductor industry, make up for their own technology, semiconductor raw materials shortcomings.

In 2021, the NPC and CPPCC will issue the Outline of the 14th Five-Year Plan of The People's Republic of China for National Economic and Social Development and the Vision Goal of 2035, which sets the development of the third generation of semiconductor materials as the focus of national development. Which pointed out that our country should concentrate superior forces and increase of the semiconductor industry overcome difficult, break through the foreign technology blockade, efforts to solve the related problem, in the third generation of semiconductor materials development situation, the original of the third generation of semiconductor single crystal substrate, photoelectron, modules, power electronics, radio frequency devices such as advanced derivatives goal programming, The plan is to achieve more than 50 percent penetration of domestic semiconductors by 2025. In 2030, a group of semiconductor enterprises will be derived to enter the world level to achieve leapfrog development.



1.1.2. Overview of Semiconductor Economic Development

According to the China Semiconductor Industry Association, China's IC industry generated sales of 884.8 billion yuan in 2020, up 17 percent year on year. In terms of market segments, the IC design industry accounted for 44.6% of the IC market in the first three quarters of 2020, while the sealing and testing industry and wafer manufacturing industry accounted for 26.4% and 29%, respectively. Its market size in the first three quarters reached 590.59 billion yuan, up 16.9% from last year. In the context of the epidemic, local semiconductor companies have quickly taken over the domestic market, breaking the monopoly of foreign semiconductor companies in the Chinese market.

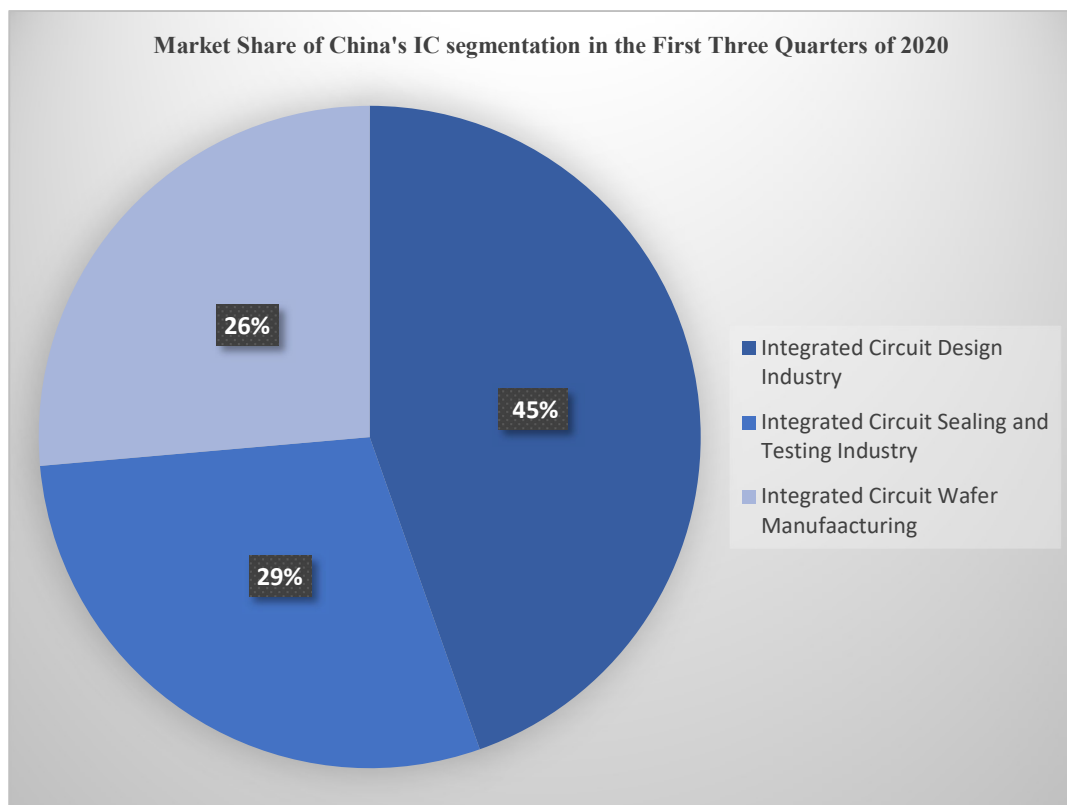


Figure 1. Market Share of China's IC segmentation in the First Three Quarters of 2020

1.1.3. Overview of Semiconductor Technology Environment

Table 1. data of The Localization Rate of Various Semiconductor Materials

Product	Localization rate in 2019	Localization rate in 2020
The Wafer	25%	80%
CMP Material	25%	40%
Photoresist	5%	20%
Light Cover Template	20%	30%
Electronic Specialty Gas	25%	31%
Wet Electron Chemical	25%	48%
Target Material	10%	16%

Data from China Securities Research Department.

China's semiconductor industry has achieved certain competitiveness in manufacturing, packaging, design and other aspects, that is, a breakthrough in the 7nm process is in prospect, the design level of ASIC chip is in the forefront of the world, and the market share of sealed test is stable and rising. Among them, China has more than 100 billion potential third generation semiconductor device replacement scale, among which the implementation speed is fast in 5G communications, consumer electronics and new energy vehicles. The localization rate of various semiconductor materials has been greatly improved, and the comparison is as follows.

1.2. Development Status of Various Generations of Semiconductor Materials Industry

The first generation of semiconductor materials are mainly silicon and germanium semiconductor materials. In the early 1950s, Si and Ge materials were widely used in integrated circuits and Ge materials were used in low voltage, low frequency, medium power transistors and photodetectors. In 1959, the single crystal of silicon was drawn. 1962 developed silicon epitaxial process, began to study the photographic plate and lithography process, and in the following two years have been made of silicon planar transistors and silicon epitaxial planar transistors.

The second generation of semiconductor materials are gallium arsenide and indium phosphide. Among them, gallium arsenide and indium phosphide materials have better performance than the first generation of semiconductor materials, and can manufacture high-power luminous electronic components, mechanical components, etc. At present, China mainly relies on imports for the second generation of semiconductor materials, and the localization rate of the second generation of semiconductor materials is low. [1] A group of related enterprises in the yunnan germanium industry are trying to break through related technologies, overcome technical problems and break through technical bottlenecks.

The third generation of semiconductor materials are gallium nitride, silicon carbide, zinc oxide, diamond. Since the beginning of the 21st century, China has made great efforts to develop the semiconductor industry and 5G communications, consumer electronics and other industries based on its own advantages. Based on the characteristics of high temperature, high voltage and high intensity current resistance of the third generation semiconductor materials, gallium nitride technology is used to construct 5G base station rf devices. In terms of consumer electronics, mainstream manufacturers such as Xiaomi, OPPO and Huawei have successively launched related electronic products with high power and small volume using gallium nitride as raw material.

To sum up, the Chinese in the hands of each generation of semiconductor materials to present a positive trend, each generation of material localization rate is increasing, and China's semiconductor industry in the manufacturing, packaging and design have a certain competitiveness, 5G communication, quantum communication, new energy automotive industry among the world's top semiconductor applications such as, in view of this, China's semiconductor market has a broad prospect, but the technology manufacturing needs to break through the foreign technology blockade.

2. Hefei Semiconductor Status Quos

2.1. Plan Early

The pain of China's "lack of chip" was well known to the public, and it was not until the ZTE incident in 2018 that China was inspired to solve the "lack of chip". But as a government decision, Hefei's perception of the lack of core preceded that of most Chinese provinces. [2] In 2013, Hefei took the lead in issuing the Hefei Integrated Circuit Industry Development Plan (2013-2020). Hefei city began to vigorously promote the integration of integrated circuit and

equipment manufacturing, household appliances and other industries, and will focus on the "core" in the field of IC design, intended to IC design as a breakthrough point, promote the development of the overall industry.

Now the semiconductor industry in Hefei has begun to take shape. There are 253 integrated circuit industries in Hefei such as Jifa Technology, Chaoyi Innovation and Qunlian Electronics, among which there are 10 enterprises with annual sales revenue of more than 100 million yuan. According to Hefei Statistical Yearbook, after six years of Hefei semiconductor separator output is on the rise, to 2019 has reached 1.05079 million output. [3]

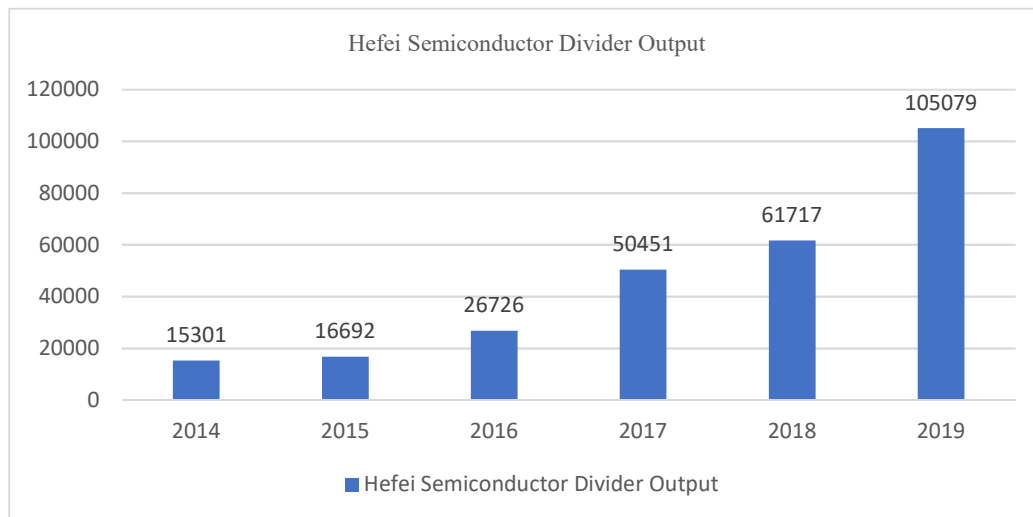


Figure 2. 2014-2019 years of Hefei semiconductor separator output

2.2. Highlight the Introduction of Major Projects

Hefei put forward the strategy of "Establishing the City by Industry" in 2005. With the support of the policy, Hefei TFT-LCD project, the largest LCD panel production base in Mainland China, has been settled in Hefei High-tech Zone, which means the first 5-generation LCD production line in China will be settled in Hefei. Two years after its arrival in Hefei, BOE's sixth-generation LCD panel production line was successfully put into operation, which not only ended China's dependence on imported large-size LCD panels, but also changed the situation of Hefei's "economic depression".

In January 2018, the Chinese mainland's first 10.5 generation optical mask project was launched in Hefei, another major science and technology infrastructure construction project after Beijing's new airport and Shanghai's Zhangjiang High-tech Park, according to Hefei Semiconductor Association. The successful construction of the project will greatly promote the development of China's IC industry and break the current situation of China's total dependence on imported optical masks. [4] In the same year, the largest COF coil production base for semiconductor display chip packaging in Mainland China was built in Hefei.

In addition to loss-making BOE, Hefei also established Hefei Changxin in 2017 and invested in Nio in 2020, three projects that allowed the city to successfully integrate "screen" and "core."

2.3. Focus on Domestic Substitution

In the field of integrated circuits, Hefei develops late and has little accumulation, so it mainly introduces mature companies at present. However, how to realize Hefei's originality in the field of chips has always been an important issue in the development of Hefei semiconductor industry.

In 2016, Changxin Company was founded in Hefei and invested by Hefei Municipal government. The project will cost \$150 billion and be carried out in three phases. In September 2019,

Changxin launched its first product DDR4 chip, and in May 2020, it launched a memory chip equipped with Changxin DDR4 particles. [5] Changxin Storage has completed its first 12-inch wafer fab and officially started production, becoming the first company in mainland China to mass-produce DRAM chips. Changxin said on January 14, 2022 that DRAM capacity has reached 60,000 wafers per month in 2021 and is expected to double to 120,000 wafers per month by 2022.

3. Main Problems in the Development of Hefei Semiconductor Equipment Industry

3.1. Less Domestic Advantage in Core Technology

Although Hefei is located in the Long Delta city group of China, it does not belong to the region where semiconductor technology occupies the advantage. Compared with Shanghai, which is "The first semiconductor city in China", Hefei still has a long way to go. In Hefei in recent years, the semiconductor industry is thriving, development in full swing, successively have certain objective quantity of semiconductor company was born in this city, Hefei also introduce strong semiconductor company, in 2008, Hefei government will 6 generation lines in Hefei boe, since then, Beijing Oriental as the core of a series of supply chain has been built more and more perfect. With the support of the state and Hefei municipal government, the city's semiconductor related technology has made a great breakthrough, but due to the late start of Hefei semiconductor industry, product quality and other aspects, there is still a big gap between the domestic semiconductor development advantages of the region, Hefei semiconductor products in the domestic market share is not high.

3.2. Innovation and Industrial Chains are not Closely Linked

Hefei semiconductor industry chain has developed rapidly in the past decade. Was established since 2013, in Hefei semiconductor industry development co., LTD., in 2016, Hefei joint signs of easy innovation jointly set up long xin storage, to the world's four major manufacturers of semiconductor equipment Japan Ren original production wholly foreign owned enterprise Hefei Ren original precision machinery co., LTD factory in Hefei by the open area was built in 2021[6]. However, Hefei semiconductor innovation technology can not be well combined with the industrial chain, technology research and development can only be based on the stipulated conditions of the laboratory, there is no opportunity for practice, so it can not be put into mass production. This is always a heart disease of Hefei semiconductor industry development.

3.3. Insufficient Innovation and Competitiveness of Enterprises

At present, although Hefei is located in the Yangtze River Delta urban agglomeration, it is still at a disadvantage compared with other cities. Limited by the lack of financial resources and technological development, Hefei semiconductor enterprises produce products lack of competitiveness, in the market is not how to be favored by consumer enterprises, product market share is low, especially in the production scale is relatively large to obtain high profits in the market appears insufficient competitiveness. So far, cost and technological innovation have greatly limited the growth of Hefei semiconductor companies. Most semiconductor enterprises in Hefei lack of technological innovation consciousness and innovation ability, and most of them have not invested a lot of money in technological innovation. In the long run, the competitiveness of enterprises in the domestic market will be greatly damaged.

3.4. The Talent Structure and Team Building are not Perfect

At present, Hefei semiconductor industry related talents in quality, quantity, structure and team construction are not perfect. Although there are some famous science and technology universities in Hefei, such as University of Science and Technology of China and Hefei University

of Technology, the core talents provided by these universities are not enough for the development of the semiconductor industry in Hefei. And at present the city set up by the departments of colleges and universities subject, school training of talents mostly prefer to theoretical research or practical, the lack of mastering the whole industry chain management talents, committed to the core technology research and development of applied talents is extremely scarce, most of the talents in colleges and universities can only in the laboratory or calculus paper technology talent to show them. The engineering experiment conditions provided by the school are also very limited and cannot meet the needs of students studying applied subjects such as semiconductors. [7] All in all, the quantity and quality of relevant talents in Hefei can not meet the development of the semiconductor industry in Hefei.

4. Countermeasures

4.1. Improving the Development Ability of Core Technologies

As the so-called "science and technology is the first productivity", the lack of technology will lead to the shortage of productivity of Hefei semiconductor industry. The technological dilemma faced by Hefei can be solved in two ways: first, due to the slowdown of Moore's Law, Hefei can give full play to its advantage of being a late comer, actively introduce advanced technologies at home and abroad, narrow the technological gap and improve the development capacity. Second, the government allocates special technology research and development fees and patent incentive funds to enterprises to improve Hefei's independent research and development capabilities.

4.2. Promoting Collaborative Innovation among Enterprises, Universities and Research Insititutes

In the field of semiconductors, enterprises, universities and research institutes should be encouraged to establish strategic alliances, carry out technological exchanges and sharing, and accelerate the industrialization of semiconductors. [8] To establish a national independent innovation demonstration zone, take advantage of the existing semiconductor technology companies, scientific research institutions and university science parks in Hefei, encourage the three to jointly set up research and development institutions and joint laboratories, deepen the docking of industries, universities and research institutes, and carry out scientific research cooperation and exchanges. Integrate all resources, open up the innovation chain and industrial chain, transform into the semiconductor industry productivity, promote economic development.

4.3. Focusing on Enterprise Development and Innovation

Enterprises are important carriers of scientific and technological development and innovation. The government can encourage enterprises to innovate by setting up special funds, giving enterprises enough research funds, and issuing preferential policies for innovative enterprises. We should not only create a level playing field for existing enterprises, but also guide them to compete on an equal footing, so that the survival of the fittest can be eliminated. We should promote rational allocation of industry resources through mergers and reorganizations, and enhance enterprises' competitiveness and innovation capacity.

4.4. Strengthening the Team Construction of Highly-skilled Personnel

Talent is the first resource, the fundamental source of national scientific and technological innovation lies in people. In terms of talent training, Hefei should make full use of existing universities, actively promote school-enterprise cooperation, strengthen the construction of training system and build special industrial parks. [9] College students can practice in industrial parks to gain practical knowledge. Enterprises can also select outstanding talents among

interns to inject vitality into enterprises, so as to achieve a win-win situation. Enterprises should also conduct regular job training for employees of technology companies so that researchers can keep abreast of the latest technologies and trends. Carry on the comprehensive management to the staff, establish the perfect assessment and evaluation mechanism, build a comprehensive high-quality leading talent team. The government should actively introduce policies to attract talents, reduce the living costs of foreign talents, and attract semiconductor technical talents from all over the country to settle in Hefei.

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