SEMICONDUCTOR TECHNOLOGY COMPETITION SEEN THROUGH PATENT ANALYSIS

— UNSTABLE INTERNATIONAL COOPERATION AND THE DEMAND FOR INTELLECTUAL PROPERTY STRATEGY —

Ryusuke Ishiguro
Intellectual Property Dept., Technology & Innovation Studies Div.
Mitsui & Co. Global Strategic Studies Institute

SUMMARY

- Semiconductors are increasingly regarded as a strategic resource central to national security, with US-China tensions severely impacting international collaboration in technology development and supply chains.
- Patent analysis reveals a clear contrast: US firms are pursuing open innovation by actively referencing international technologies, while Chinese firms are strengthening strategies prioritizing domestic development and markets.
- Companies must enhance their technological capabilities through international collaboration and licensing. Patent information is a vital strategic tool for selecting partners and managing geopolitical risk.

1. CHANGES IN THE INTERNATIONAL ENVIRONMENT SURROUNDING SEMICONDUCTORS

1-1. GEOPOLITICAL TENSIONS AND THE RESTRUCTURING OF SUPPLY CHAINS

In recent years, the intensifying rivalry between the US and China has placed significant constraints on the international production structure of the semiconductor industry. The US has imposed restrictions on the export of advanced technologies to China on the grounds of national security, while China is working to achieve technological self-sufficiency. Under these conditions, countries are seeking to strengthen domestic production capacity and partner with trusted allies in order to ensure stable semiconductor supplies. Semiconductors are increasingly regarded as a strategic resource directly linked to national security and economic strategy, and competition over their procurement is now having an impact on diplomatic relations.

Taiwan, in particular, plays a critical role in the supply of advanced semiconductors as it is home to Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest contract semiconductor foundry, which has advanced process technologies for 5nm and below. TSMC is an indispensable partner for major US companies such as Apple and NVIDIA. As tensions rise over the Taiwan Strait, the future of the region has become a direct risk factor for the global semiconductor supply chain.

The US, for its part, has imposed strict export controls on semiconductor manufacturing equipment and design software due to concerns over the potential military use of advanced technologies by China[1]. In July 2025, the US Department of Commerce partially lifted its export ban on design software, allowing services to China to resume[2]. However, this is seen as a temporary measure linked to progress in US-China negotiations, and restrictions could be reinstated depending on future developments.

Amid uncertainty over the direction of technology controls, companies are being forced to respond with both flexibility and caution. The situation is also influencing supply chain strategies and the direction of research and development. The geopolitical landscape surrounding semiconductors is expected to become even more complex, making it essential for companies to develop medium- to long-term strategies that take into account geopolitical risks.

2. TRENDS IN THE SEMICONDUCTOR SECTOR FROM A PATENT PERSPECTIVE

Intellectual property (IP) strategy refers to the policies and methods by which companies and nations utilize patents and other forms of IP to maintain and strengthen technological capabilities and enhance international competitiveness. As geopolitical tensions prompt a restructuring of global supply chains, the importance of patent analysis as a tool for assessing the direction and strategy of each company's research and development is increasing. Identifying which companies lead in specific technologies and which countries are focusing on particular areas supports competitive positioning, strategic partner selection, and risk management. Continuous monitoring of patent information is therefore essential. This report examines the current state of IP strategies in the semiconductor industry through analysis of semiconductor design and manufacturing patents[3], while also exploring responses to geopolitical risks and opportunities for international expansion.

2-1. PATENTS RELATED TO ELECTRONIC DESIGN AUTOMATION (EDA) AND OTHER SEMICONDUCTOR DESIGN TECHNOLOGIES

EDA refers to a suite of tools that automate and optimize circuit design and are essential for completing complex semiconductor designs with high precision in a short timeframe. It serves as a core component of semiconductor development. The left side of Figure 1 shows the top 20 companies and research institutions ranked by number of patents held in this field, while the right side highlights recent trends in their patent holdings. Among US companies, Synopsys and Cadence Design hold the largest patent portfolios. On the Chinese side, State Grid stands out as a key player. In recent years, it can be seen that Chinese companies, research institutes, and universities have become increasingly active in patent filings in this sector.

---

1 Source: https://public-inspection.federalregister.gov/2022-21658.pdf (accessed July 15, 2025) , https://aait.co.jp/archives/72760 (accessed July 15, 2025)

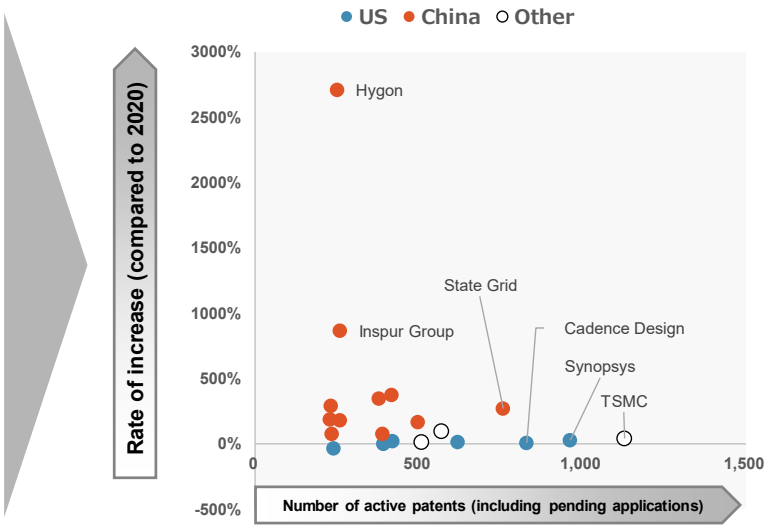
2 Source: https://www.bloomberg.co.jp/news/articles/2025-07-03/SYSS0NT1UM0W00 (accessed July 15, 2025)

3 Search criteria (semiconductor design) : (IPCSmart=(G06F 30/30, G06F 115, G06F 117) OR (TitleAbstractClaims=(((semiconductor OR "IC" OR circuit OR "LSI") NEAR (design OR layout OR lay_out OR "RTL" OR netlist OR floorplan* OR floor_plan* OR verif* OR synthes*)) OR "EDA" OR electronic_design_automation) AND IPCSmart=(G06F 17/50, G06F 30/20, G06F 119))), Search filter: Semiconductor manufacturing: (TitleAbstractClaims=(Semiconductor OR "IC" OR integrated_circuit OR "LSI") OR IPCSmart=(H01L 21, H10)) AND (TitleAbstractClaims=(((manufactur* OR poduc* OR etch* OR deposition OR lithography OR "CMP" OR ion_implantation OR wafer_process*) NEAR (machine OR equipment OR tool))) OR IPCSmart=(C23C 14, C23C 16, C23F 1, C30B, G01N 21, G03F))(All using LexisNexis PatentSight+, active patents as of July 2025 including pending application)

Figure 1: US technological strength and China's rapid advancement indicated by patent trends in the semiconductor design sector

#	Company/Organization	Country
1	TSMC	Taiwan
2	Synopsys	US
3	Cadence Design	US
4	State Grid	China
5	AMD	US
6	Samsung	S.Korea
7	Siemens (*)	Germany
8	Chinese Academy of Sciences	China
9	Intel	US
10	China Southern Power	China
11	IBM	US
12	Inspur Elec. Info. Ind.	China
13	CETC	China
14	Inspur Group	China
15	Xidian University	China
16	Hygon	China
17	GlobalFoundries	US
18	Institute of Microelectronics	China
19	UESTC	China
20	CASC	China

(*) Acquired EDA giant Mentor Graphics (US) for approximately USD 4.5 billion (approximately JPY 495.6 billion at the time of acquisition in April 2017)



Source: Compiled by MGSSI based on LexisNexis PatentSight data

Figure 2 shows the share of patent filings in the US and China among the top 20 companies and research institutions in terms of number of patents. US companies such as Synopsys and Cadence Design have a high proportion of filings in US. Chinese companies and research institutions, on the other hand, file almost exclusively in China, indicating an IP strategy focused on the domestic market. Companies outside these two countries tend to file relatively evenly in both markets, suggesting a strategy aimed at international technology protection.

Figure 2: Differences in IP strategies of leading players in the semiconductor design sector based on filing location

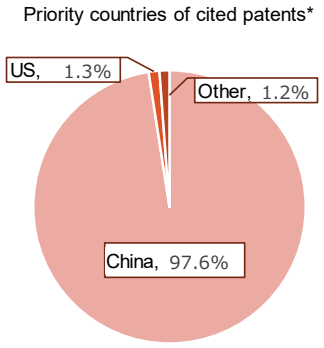
#	Company/Organization	Country	Share of filings in the US	Share of filings in China
1	TSMC	Taiwan	95%	49%
2	Synopsys	US	97%	24%
3	Cadence Design	US	100%	0%
4	State Grid	China	1%	100%
5	AMD	US	96%	14%
6	Samsung	Korea	94%	59%
7	Siemens (Note)	Germany	91%	15%
8	Chinese Academy of Sciences	China	1%	99%
9	Intel	US	95%	31%
10	China Southern Power Grid	China	0%	100%
11	IBM	US	98%	11%
12	Inspur Elec. Info. Ind.	China	5%	99%
13	CETC	China	2%	100%
14	Inspur Group	China	0%	100%
15	Xidian University	China	0%	100%
16	Hygon	China	1%	100%
17	GlobalFoundries	States of A	96%	16%
18	Institute of Microelectronics	China	1%	99%
19	UESTC	China	1%	100%
20	CASC	China	0%	100%

*Acquired EDA giant Mentor Graphics (US) for approximately USD 4.5 billion (approximately JPY 495.6 billion at the time of acquisition in April 2017)

Source: Compiled by MGSSI based on LexisNexis PatentSight+ data

Figures 3 and 4 show the proportion of cited prior patents by priority country (the country where the cited patent was first filed) for patents held by leading players in China and the US. Among the patents held by Chinese companies and research institutions, 97.6% of the cited prior patents were originally filed in China, and there are few references to patents first filed in other countries. This suggests that development in China is being driven by domestic technologies, with a focus on building technological capabilities to meet internal demand. In contrast, among patents held by US companies, 67.8% of the cited prior patents were first filed in the US, while 18.6% were filed in China and 13.6% in other countries. This indicates that US companies are influenced not only by domestic technologies but also by innovations from abroad. The notably high proportion of references to patents originating in China indicates that China's technological capabilities can no longer be ignored.

Figure 3: Development strategy led by domestic technologies in China as seen from priority countries of cited patents (semiconductor design sector)

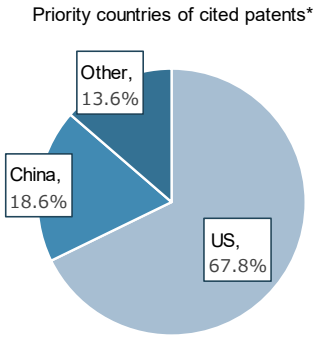


*The country in which the patent was first filed

#	Top Chinese companies and institutions	Number of patents (as of July 2025)
4	State Grid	758
8	Chinese Academy of Sciences	499
10	China Southern Power Grid	418
12	Inspur Elec. Info. Ind.	392
13	CETC	380
14	Inspur Group	261
15	Xidian University	261
16	Hygon	253
18	Institute of Microelectronics	236
19	UESTC	234
20	CASC	230

Source: Compiled by MGSSI based on LexisNexis PatentSight data

Figure 4: The presence of China in US companies' technological development as seen from priority countries of cited patents (semiconductor design sector)



*The country in which the patent was first filed

#	Top US companies and institutions	Number of patents (as of July 2025)
2	Synopsys	965
3	Cadence Design	830
5	AMD	620
9	Intel	422
11	IBM	393
17	GlobalFoundries	241

Source: Compiled by MGSSI based on LexisNexis PatentSight data

2-2. PATENTS RELATED TO SEMICONDUCTOR MANUFACTURING EQUIPMENT

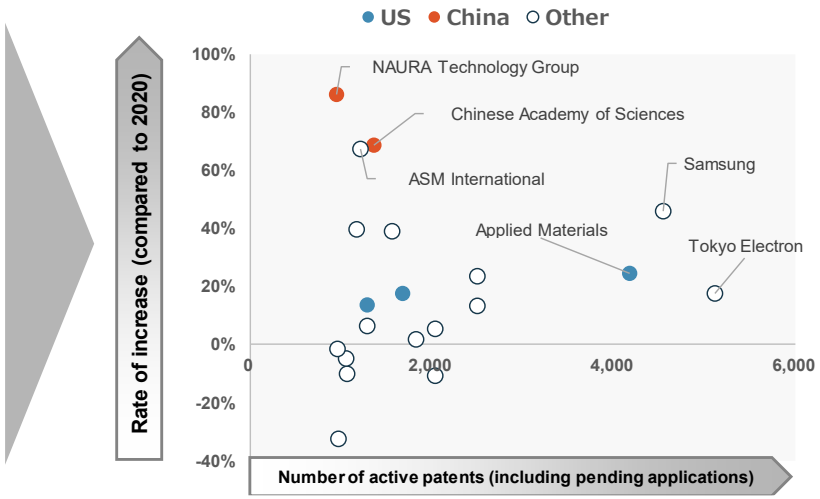
Equipment for advanced semiconductor manufacturing is essential for forming extremely fine circuits and is regarded as a strategic asset directly linked to technological innovation, national competitiveness, and security. The left side of Figure 5 shows the number of active patents held by the top 20 companies in the semiconductor manufacturing equipment sector, while the right side indicates their patent holdings and the growth rates compared to 2020. Chinese companies and research institutions, such as NAURA Technology Group and the Chinese Academy of Sciences (CAS), have significantly increased their number of patents in recent years, reflecting China's strategy to achieve technological self-sufficiency. On the other hand, Applied Materials (US) and Lam Research (US) continue to rank among the top in total patents, but the growth rates of their holdings are relatively modest, indicating they are maintaining a mature technological foundation. These results highlight a contrast between companies deepening existing technologies and those focusing on new innovations. They

also point to the growing prominence of Chinese players in the semiconductor equipment sector and the shifting competitive landscape.

Figure 5: Shifts in the competitive landscape as seen from patent counts and growth rates in the semiconductor manufacturing sector

#	Company/Organization	Country
1	Tokyo Electron	Japan
2	Samsung	S.Korea
3	Applied Materials	US
4	TSMC	Taiwan
5	Canon	Japan
6	ASML	Netherlands
7	Shin-Etsu	Japan
8	Fujifilm	Japan
9	Lam Research	US
10	Samsung Display	S.Korea
11	Chinese Academy of Sciences	China
12	KLA	US
13	Sumitomo Chemical	Japan
14	ASM International	Netherlands
15	Kokusai Electric	Japan
16	Toshiba	Japan
17	Tokyo Ohka	Japan
18	Nikon	Japan
19	JIC (*)	Japan
20	NAURA Technology Group	China

(*) Japan Investment Corporation (JIC) acquired semiconductor materials giant JSR (Japan) with the aim of strengthening the competitiveness of Japan's semiconductor industry (completed in July 2024)



Source: Compiled by MGSSI based on LexisNexis PatentSight data

Figure 6 shows the proportion of patent filings in the US and China by the top companies and research institutions based on the number of semiconductor manufacturing patents held. Many companies have a high filing ratio in the US, indicating that the US market remains a key jurisdiction for technology protection. In contrast, rapidly growing Chinese companies and research institutions prioritize domestic filings. In particular, Chinese Academy of Sciences (CAS) and NAURA Technology Group file nearly all of their patents in China, reflecting a strategic focus on technological self-sufficiency and domestic market protection.

Figure 6: Geographic trends in patent filings in the semiconductor manufacturing sector and the rise of China

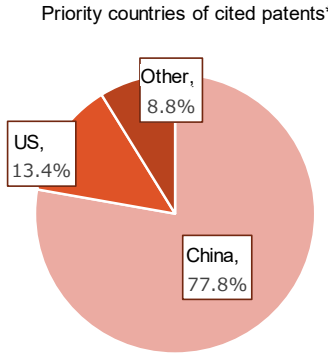
#	Company/Organization	Country	Share of filings in the US	Share of filings in China
1	Tokyo Electron	Japan	65.1%	41.5%
2	Samsung	Korea	75.2%	43.7%
3	Applied Materials	US	81.4%	54.9%
4	TSMC	Taiwan	89.5%	49.0%
5	Canon	Japan	54.2%	38.0%
6	ASML	Netherlands	79.4%	55.7%
7	Shin-Etsu	Japan	61.7%	38.7%
8	Fujifilm	Japan	38.8%	23.6%
9	Lam Research	US	79.4%	63.1%
10	Samsung Display	Korea	73.3%	60.9%
11	Chinese Academy of Sciences	China	9.9%	98.2%
12	KLA	US	93.5%	54.5%
13	Sumitomo Chemical	Japan	33.6%	25.3%
14	ASM International	Netherlands	94.7%	62.1%
15	Kokusai Electric	Japan	83.2%	56.9%
16	Toshiba	Japan	61.8%	20.4%
17	Tokyo Ohka	Japan	49.0%	10.4%
18	Nikon	Japan	39.9%	25.6%
19	JIC (注)	Japan	33.7%	14.0%
20	NAURA Technology Group	China	8.0%	98.8%

*Japan Investment Corporation (JIC) acquired semiconductor materials giant JSR (Japan) with the aim of strengthening the competitiveness of Japan's semiconductor industry (completed in July 2024)

Source: Compiled by MGSSI based on LexisNexis PatentSight data

Figures 7 and 8 compare patent citation trends of top patent holders by country. Among Chinese companies and research institutions, 77.8% of the prior art they cite originates from within China. CAS and NAURA Technology Group are especially focused on accumulating and utilizing domestic technologies. On the other hand, while about half of citations by US companies refer to patents filed in the US, they also cite a substantial proportion of patents from other countries such as Japan, China, and South Korea. These comparisons reveal that Chinese companies tend to favor domestic development, while US firms place greater emphasis on open innovation.

Figure 7: Reliance on domestic technology and orientation toward in-country development as seen from patent citation trends among Chinese companies (semiconductor manufacturing sector)

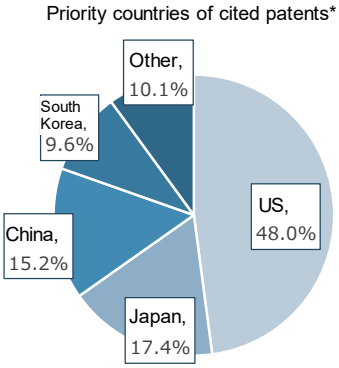


*The country in which the patent was first filed

#	Top Chinese companies and institutions	Number of patents (as of July 2025)
11	Chinese Academy of Sciences	1,363
20	NAURA Technology Group	951

Source: Compiled by MGSSI based on LexisNexis PatentSight data

Figure 8: Orientation toward international collaboration as seen from patent citation trends of US companies (semiconductor manufacturing sector)



*The country in which the patent was first filed

#	Top US companies and institutions	Number of patents (as of July 2025)
3	Applied Materials	4,173
9	Lam Research	1,675
12	KLA	1,292

Source: Compiled by MGSSI based on LexisNexis PatentSight data

3. THE NEW GEOPOLITICAL LANDSCAPE OF THE SEMICONDUCTOR INDUSTRY

3-1. GLOBAL EXPANSION LEVERAGING PATENTS

In recent years, some Chinese companies have shifted their strategies from traditional product exports to revenue generation through licensing. A notable example is battery giant CATL, which has adopted a technology licensing business model to avoid intensifying competition and geopolitical risks in overseas markets[4]. Going forward, Chinese semiconductor companies may also pursue similar strategies. However, as the US continues to strengthen exclusionary policies against Chinese firms, such collaboration models also face the risk of

[4] Source: https://www.reuters.com/business/autos-transportation/china-battery-giant-catl-would-build-us-plant-if-trump-allows-it-2024-11-13/?utm_source=chatgpt.com (accessed July 15, 2025), https://news.qq.com/rain/a/20240328A0AG5800 (accessed July 15, 2025), https://www.bloomberg.co.jp/news/articles/2025-07-14/SZE49SDWLU6800 (accessed July 15, 2025), https://www.bloomberg.co.jp/news/articles/2024-03-25/SAW7EHT0G1KW00 (accessed July 15, 2025)

becoming subject to regulatory restrictions[5]. Meanwhile, Rapidus (Japan) is working to quickly adopt cutting-edge technologies through joint development with multiple partners, including IBM[6]. This serves as a strong example of the importance of international technology collaboration in the semiconductor industry, where patent and trade secret disputes are common. Rapidus aims to enhance its technological capabilities through such cooperation and to secure competitiveness in the global market. In this way, patents are no longer merely a defensive tool but a key to strategic growth.

3-2. CHINA'S PURSUIT OF TECHNOLOGICAL SELF-SUFFICIENCY

Amid escalating US-China tensions and restrictions on imports of advanced semiconductors, China is rapidly working to strengthen its domestic development capabilities. One particularly notable example is the inclusion of a 7 nm chip manufactured by Semiconductor Manufacturing International Corporation (SMIC) in Huawei's latest smartphone, which has come to symbolize China's push for technological self-sufficiency. China is also gaining ground in the field of AI. For example, large language models such as DeepSeek have emerged, accelerating efforts to compete with the US lead in AI technologies. These developments indicate that China is moving beyond imitation and pursuing its own technological innovation.

4. THE PRESENT AND FUTURE OF THE SEMICONDUCTOR INDUSTRY FROM AN IP PERSPECTIVE

Amid growing tensions between the US and China, the semiconductor industry is increasingly regarded as a critical national asset. Disruptions to supply chains and technology restrictions are undermining international cooperation. Patent data reveals that while US companies are leaning into open innovation by actively referencing foreign patents and technologies, Chinese companies are strengthening their focus on domestic development and markets. In this context, US firms will need to deepen collaboration with allied countries to maintain their technological advantage. Meanwhile, it will be vital for Chinese companies pursuing self-reliance to expand globally through licensing. For companies in other countries, it is important to avoid overdependence on either the US or China and instead leverage patents to build international partnerships and diversify technologies, thereby mitigating geopolitical risks while enhancing competitiveness. The semiconductor industry is expected to face continuing political and economic volatility, and IP strategies may significantly impact the survival and growth of companies in the near future.

5 Source: https://www.digitimes.com/news/a20250609PD219/catl-plant-ford-gotion-partnership.html?utm_source=chatgpt.com (accessed July 15, 2025)

6 Source: https://www.rapidus.inc/news_topics/news-info/press-release-ibm-rapidus/ (accessed July 15, 2025), https://www.rapidus.inc/news_topics/news-info/rapidus-and-tenstorrent-agree-to-joint-ip-development/ (accessed July 15, 2025)