

Mapping Semiconductor Patent Growth: Global Developments and India's Strategic Position

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Abstract— India's Semiconductor Mission 2025 is a strategic effort to reduce import dependence, promote domestic manufacturing, and establish India as a major global player in the field of advanced electronics. While current policies prioritize infrastructure, investment, and skills development, the role of intellectual property rights, especially patents, has not yet been fully studied. Patents are critical in the semiconductor industry worldwide, driving innovation and competitive advantage. Countries like the United States, Taiwan, South Korea, and China have established their dominance in the semiconductor sector through strong patent systems and sustained research investment. This study critically examines India's semiconductor patent ecosystem, the challenges faced by domestic innovators, and policy shortcomings. It highlights the urgent need for reforms to enhance competitiveness, protect innovation, and achieve the goals of the Semiconductor Mission 2025.

Index Terms— Semiconductor innovation, Intellectual property rights, Patent ecosystem, Semiconductor Mission 2025, Technology competitiveness

I. INTRODUCTION

Semiconductors are the core technology behind nearly all modern electronic devices from smartphones and computers to medical devices and defence systems. Because the semiconductor industry is highly competitive and relies on continuous innovation, protecting new inventions through patents and intellectual property rights (IPRs) is essential. Patents grant inventors exclusive rights to their creations for a fixed period, encouraging companies and researchers to invest heavily in research and development (R&D) with the certainty that they can profit from their innovations. Developing new semiconductor technologies is extremely expensive and often involves building on previous inventions, so patent protection is crucial to accelerating industry growth and maintaining a competitive edge. Globally, the

semiconductor sector is one of the most patent-intensive sectors, meaning the number and quality of patents are closely linked to a country's technological leadership and pace of innovation.

Countries like the United States, Taiwan, South Korea, and China have become global leaders in chip design and manufacturing by combining strong intellectual property laws with significant public and private investment in research and development. In contrast, India's semiconductor policy has focused primarily on building infrastructure, providing financial incentives, and forging partnerships with foreign companies, while less attention has been paid to developing strong patent and intellectual property strategies.

Most academic and policy discussions on patent law in India have focused on sectors such as pharmaceuticals, biotechnology, and software, leaving a significant gap in research and policy guidance specific to semiconductors. While Indian government reports talk about building manufacturing capacity and providing incentives, they do not adequately address how patent and intellectual property frameworks can foster innovation and help India compete globally in the semiconductor sector.

II. OBJECTIVE

1. To map semiconductor-related patent filings in India and assess the country's share in the global semiconductor patent landscape.
2. To identify regulatory gaps and challenges facing domestic innovators under the current Patent Act, 1970, and to examine how the strategic objectives of the Semiconductor Mission 2025 can be aligned with necessary patent ecosystem reforms.
3. To examine India's progress in seminal innovation compared to global leaders such as the United States, Taiwan, South Korea, and Japan, and to

analyse current challenges and comparative perspectives.

These findings aim to contribute to both academic discourse on intellectual property (IPR) in emerging technologies and practical policy formulation to strengthen India's innovation ecosystem.

III. MATERIALS AND METHODS

This study adopts a qualitative and exploratory research design, complemented by a quantitative analysis of semiconductor-related patent data. The qualitative component focuses on policy analysis and comparative legal review, while the quantitative aspect involves assessing patent filing trends in key jurisdictions.

IV. DATA SOURCES

Patent Databases: Indian Patent Office (IPO) Annual Reports (2022-23, 2023-24), WIPO Patent Scope and WIPO World Intellectual Property Indicators (2022, 2023, 2024), TIPO Annual Statistics (2024), USPTO, CNIPA, and EPO Patent Datasets

Policy Documents: Ministry of Electronics and Information Technology (MeitY) (2021), India Semiconductor Mission Framework, Press Information Bureau (PIB) Releases and Official Government Communications, Industry and Market Reports, OECD Science, Technology, and Industry Outlook (2021), NOMAD Patent Intelligence Report (2025)

Academic Literature: Scholarly studies and commentaries on Indian IP law, the semiconductor innovation ecosystem, and comparative patent regimes.

V. ANALYSIS APPROACH

This study uses a three-pronged analytical framework combining quantitative, comparative, and strategic analysis:

- The quantitative patent analysis assesses trends in semiconductor patent filing in India by studying

data from the Indian Patent Office and global databases. It looks at the number of filings, patterns of growth, and key areas of semiconductor innovation.

- The comparative analysis compares India's semi-annual patent activity with that of global leaders such as the US, China, Taiwan, and South Korea to identify India's relative strengths, weaknesses and opportunities in innovation and patent competitiveness.
- The Negotiated Gap Assessment assesses how well India's semi-annual mission (2021-2025) aligns with the current patent structure, specifically the Patent Act, 1970. It sheds light on the necessary regulatory and economic reforms needed to improve India's domestically based ecological system.

VI. EVOLUTIONS

Global Landscape of Semiconductor Patent Activity

1. Patent Applications Worldwide

Globally, the number of semiconductor-related patent applications has steadily increased over the past decade. From approximately 2.56 million applications in 2013, this number will significantly increase to approximately 3.56 million by 2023 (Wipo, 2023). The largest number of applications ever filed in 2023, with leading innovation centres such as China, the United States, South Korea, and Taiwan contributing significantly. This growing trend reflects the increasingly recognized importance of patents as a strategic tool for achieving technological leadership and enhancing global market presence.

This development reflects the competitive and innovation-driven nature of the semiconductor industry, where protecting intellectual property rights is crucial to maintaining profits and attracting investment. This progress underscores the global race to establish dominance over semiconductor technologies through robust patent activity.

Year	Patent Applications Filed (approx.)	Key Observation
2013	2,564,400	Start of sustained upward trend; baseline year
2014	2,653,500	Noticeable increase as global R&D activity accelerates
2015	2,847,900	Marked annual growth; strong innovation environment

2016	3,073,800	Global filings cross 3 million; signalling rising IP importance
2017	3,121,100	Steady growth; emerging technologies drive filings
2018	3,289,200	Further climb; impact of semiconductor and high-tech sectors
2019	3,188,600	Slight dip, reflecting global uncertainty or policy changes
2020	3,234,100	Resilience in filings despite challenges (e.g., pandemic)
2021	3,254,000	Recovery and growth; renewed innovation drive
2022	3,121,200	Stable filings; continued focus on strategic patenting
2023	3,556,500	All-time high; global race for technological leadership intensifies

Patent application filed worldwide between 2013-2023

(Sources: WIPO statistics database. Last updated: May 2025 & Mathy and Squire 2024)

The table highlights not only the numbers but also the context of each year, highlighting the steady growth in patent filings worldwide and the increasing strategic value of patents in technology-focused sectors such as semiconductors.

2. Patent Applications Filed and Granted in 2023 by Different Countries

In 2023, global patent activity was concentrated in a few countries. The top five leading countries were China, the United States, Japan, South Korea, and India. China was far ahead of all other countries, with approximately 1.6 million patent applications filed and approximately 800,000 patents granted. The US and Japan remained the major contributors to global innovation. South Korea's strong performance was primarily due to its continued investment in semiconductor and display technology research.

India ranked fifth, reflecting a significant increase in its share of global patenting. Although the number of patents filed and granted in India remains low compared to the top four countries, its progress reflects growing innovation in key sectors such as digital technologies and pharmaceuticals.

Countries such as Germany, Brazil, Russia, Canada, Australia, France, and Hong Kong also recorded significant patent activity, albeit on a smaller scale, reflecting the diversity of innovation worldwide. Overall, this data highlights that most global patenting occurs in Asia – specifically China, Japan, South Korea, and India along with the United States, establishing these economies as the main canter of technology and innovation today.

Country	Patent Applications (2023)	Patents Granted (2023)	Key Highlights
China	16,19,208	7,98,347	China leads the world in both patent filings and grants, demonstrating its continued innovation surge.
USA	5,23,410	3,23,434	The United States remains at the forefront, with strong numbers reflecting its established IP ecosystem.
Japan	2,89,530	2,01,420	Japan showcases high conversion of applications to grants, highlighting efficiency in examination.
South Korea	2,37,863	1,35,188	South Korea maintains a robust filing culture, especially in electronics and semiconductors.
India	77,068	34,000	India's significant year-on-year growth in applications testifies to recent IP policy reforms.
Germany	57,213	39,408	Germany's high grant-to-application ratio signals strong innovation, particularly in engineering.
Brazil	21,719	20,850	Brazil shows almost a one-to-one ratio, indicating efficient processing and focused innovation.
Russia	22,346	23,515	Russia's granted numbers surpass applications, hinting at backlog clearance or accelerated grants.
Canada	20,316	18,407	Canada's figures reflect a stable IP environment with steady approval rates.

Australia	18,224	12,476	Australia's IP filings are moderate, with a consistent grant rate.
France	12,461	11,062	France maintains a mature IP ecosystem and competitive application-to-grant ratios.
Hong Kong	21,684	10,169	Hong Kong attracts filings as a regional innovation hub, though grant conversion is lower.

Patent application filed and granted in 2023

(Source: WIPO Statistics Database 2023) (Source: Mathy and Squire 2024)

3. Semiconductor Patents application Filed Worldwide

This shows a steady and significant increase from 43,384 admissions in 2017-2018 to a peak of 80,892 admissions in 2022-2023. This reflects the growing global demand for semiconductor innovation driven by next-generation technologies, including a recent surge in progress in the AI sector. The data are

supported by sources such as Mathis & Squire (2024) and WAPEO figures, which highlight a 22% increase from 66,416 in 2022-2023 to 80,892 in 2023-2024, with chain spanning showing a notably higher increase as it responds to US export restrictions.

Year	Semiconductor Patent Applications Filed	Key Observations
2017–2018	43,384	This period marks the base level for recent semiconductor innovation trends.
2018–2019	51,094	Filings increased, reflecting growing interest and investment in semiconductor technologies.
2019–2020	55,523	The upward trend continues, underscoring the rising significance of the sector.
2020–2021	62,774	Notable jump likely due to heightened R&D amid global chip shortages and tech expansion.
2021–2022	69,194	Continued acceleration as geopolitical and supply chain factors deepen focus on semiconductor innovation.
2022–2023	80,892	Reaches a peak, demonstrating unprecedented innovation and global attention to semiconductor patents.

Patent application filled for only semiconductor worldwide

(Source: Mathy and Squire 2024)

4. Semiconductor Patent Applications by Country

In 2023, China emerged as the global leader in semiconductor patent filings with over 20,000 applications, further cementing its role as a major innovation hub. South Korea, led by companies like Samsung and LG, ranked second with over 20,000 applications. The United States filed approximately 18,509 semiconductor patent applications, primarily contributed by companies like Samsung, LG Display, and LG Corp. Taiwan filed approximately 5,490 applications, primarily contributed by TSMC. India filed approximately 2,178 semiconductor-related applications, reflecting a stable but relatively low participation level compared to global leaders. This distribution reflects regional imbalances in semiconductor innovation

VII. LEGAL DIMENSIONS OF SEMICONDUCTOR PATENTING IN INDIA

India's semiconductor patent context is primarily governed by the Indian Patent Act, 1970. Under Section 3, certain inventions, such as abstract software, are excluded from patentability, but semiconductor-related inventions such as chip architecture, material, and process innovations can qualify for patentability if they meet the criteria of novelty, inventive step, and industrial applicability (IPO, 2023). However, Section 3(d) of the Act poses a major challenge because it limits patent protection to incremental inventions, which are highly relevant in semiconductor technology, where continuous small improvements (energy efficiency, circuit integration, durability) are crucial. This stringent standard limits the patentability of small improvements unless they

substantially increase efficacy, which disproportionately impacts SMEs and startups in India, making it difficult for them to obtain IP rights and compete with existing global competitors. Additionally, issues such as high litigation costs, delays in patent approval, and dependence on foreign technology further complicate the landscape. Despite these obstacles, the legal framework provides the foundation for patent protection, but a balance is needed to better support iterative semiconductor innovation and domestic development in this area.

VIII. EXISTING BARRIERS AND LIMITATIONS

India's semiconductor industry faces some key challenges:

Technology Access: India is heavily dependent on foreign companies like TSMC and Intel for advanced technology. This dependence means India must pay high licensing fees and faces restrictions, limiting its ability to develop cutting-edge semiconductor technologies.

Patent Delays: The Indian Patent Office takes a long time to process patent applications. This delays legal protection for innovators and creates uncertainty, making companies hesitant to invest in research and development in India.

Compulsory Licensing Limitations: Although India's patent law allows compulsory licensing, it is difficult to apply it to semiconductors because these technologies are very complex and expensive. This makes compulsory licensing less practical compared to other sectors, such as the pharmaceutical industry.

Weak Innovation Ecosystem: India invests little in semiconductor research and development. There is also a lack of collaboration between academic institutions and industry, and many companies lack awareness of intellectual property rights. This weakens India's semiconductor innovation and competitiveness.

These challenges combined are making it difficult for India to develop as a semiconductor manufacturing and innovation hub. Addressing these issues will require improving infrastructure, expediting patent processes, promoting research and development, building skilled talent, and supporting investment, as well as reducing dependence on foreign technology.

IX. INTERPRETATION AND EVALUATION

The global semiconductor patent trend from 2013 to 2023 shows a sustained and significant increase in innovation activity. This growth highlights the urgent need for a faster patent process to keep pace with the growing number of patent applications each year. China dominates the patent landscape, accounting for over 88% of semiconductor applications annually, followed by the United States, South Korea, and Taiwan. This rapid growth in applications, especially after 2018, is driven by emerging technologies such as artificial intelligence, IoT, and 5G, all of which rely heavily on semiconductor advancements.

Semiconductor patents serve as a strong indicator of a country's innovation capacity and industrial competitiveness. The increase in patent applications reflects the importance of semiconductor technology in driving advancements in electronics, transforming lifestyles, and shaping global economic patterns. While countries with established semiconductor industries continue to increase their patent activity, supported by supportive government policies and robust R&D investment, India lags with relatively few applications.

To enhance India's competitiveness in this high-tech sector, targeted policy reforms are needed to promote R&D investment, strengthen intellectual property protection, and amend patent laws, such as Section 3(d) of the Patent Act, which currently limits semiconductor patenting. Encouraging more patent applications requires developing innovation ecosystems that support incremental and breakthrough advancements to meet global market demands.

In summary, semiconductor patent statistics over the past decade reflect a dynamic and fast-paced technological landscape, where the intensity of innovation is increasing, and intellectual property plays a key role in maintaining industrial leadership. India faces the challenge of bridging this gap by fostering improved innovation infrastructure, policy incentives, and a legal framework for semiconductor technology development.

X. CONCLUSION

India has immense potential to advance its semiconductor ambitions by simplifying and expediting patent processes. While Semiconductor

Mission 2025 focuses on building infrastructure and attracting investment, the role of patents as a foundation for global semiconductor competitiveness has been relatively underrepresented. To truly establish itself as a leading innovator and chip manufacturer, India must:

- Streamline and expedite patent processes to reduce delays.
- Adopt FRAND (fair, reasonable, and non-discriminatory) licensing principles to promote fair access to technology.
- Foster stronger collaboration between industry and academia to foster innovation.
- Reform Section 3(d) of the Patent Act to better accommodate significant incremental innovations in semiconductor technology.

Creating a fair and supportive intellectual property system will protect innovation, reduce dependence on foreign technology, and significantly enhance India's role in the global semiconductor supply chain. Strengthening the patent ecosystem is not only a legal requirement but also a strategic priority aligned with the goals of the Semiconductor Mission 2025, helping India become more self-reliant and globally competitive in this critical sector.

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