

Silicon Carbide (SiC)

Patent Landscape Analysis – December 2024

*Figure out the latest IP evolutions and trends in the SiC industry.
Explore the patenting activities across the SiC supply chain.*

REPORT OUTLINE

- Silicon Carbide (SiC)
- Patent Landscape Analysis
- December 2024
- PDF >170 slides
- Excel file >19,000 patent families
- Reference: KM24005
- 4,990 EUR for a multi-user license



KEY FEATURES

- Describing the **global patenting trends**, including time evolution of patent publications, countries of patent filings, etc.
- Identifying the **main patent assignees** and the **IP newcomers** in the different segments of the supply chain.
- Determining the status of their **patenting activity** (active / inactive) and their **IP dynamics** (ramping up, slowing down, steady).
- Identifying the **IP collaborations** (patent co-filings) and **IP transfers** (changes of patent ownership).
- Providing a detailed picture of the **Chinese SiC ecosystem** focusing on the patenting activity of Chinese entities.
- **Patents categorized** in 5 main supply chain segments and 10 main sub-segments: **bulk SiC & bare SiC wafers**, **epitaxial SiC substrates** (incl. growth apparatus, finishing), **SiC devices** (diodes, planar MOSFETs, trench MOSFETs), **SiC modules** (thermal issues, parasitics, die-attach, encapsulation), **circuits**.
- **IP profile of main players:**
 - Patent portfolio **overview** (IP dynamics, segmentation, legal status, geographic coverage, etc.)
 - **Recent IP activity**.
- **Excel database** containing all patents analyzed in the report, including **patent segmentations**, links to **updated online database**, and **complete data by assignee**.

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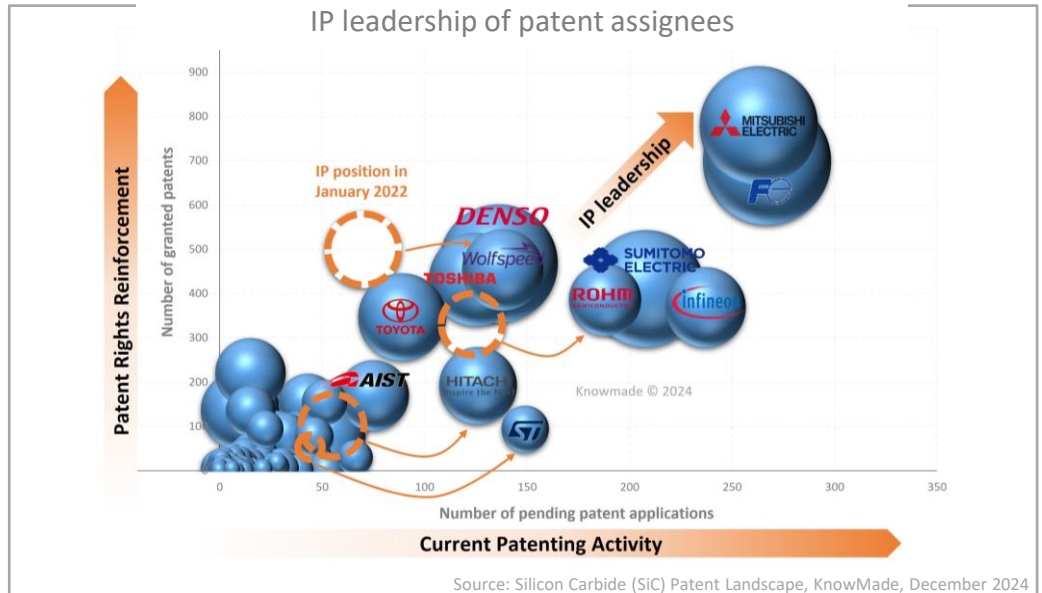
- [SiC Patent Monitor](#)
- [Next-Gen Power Module IP Report](#)

SiC technology: A complex and fast-evolving landscape

In the Silicon Carbide (SiC) patent landscape 2022, KnowMade found out that the **intellectual property (IP) activities were ramping up for SiC devices**. Many historical IP players aimed to increase the perimeter of protection for their SiC inventions at this time. Electric vehicles (EV) had been driving the emergence of the power SiC market, prompting SiC companies to file **more patents in strategic regions for this industry**, such as **Europe** and **China**. In parallel, early leaders in the young SiC market have maintained or even accelerated their IP activities to prepare for a **stronger competition in the next few years**, since the EV boom led many new players to speed up the development of SiC technology. In this context, patents may be leveraged by leading SiC companies to **protect their market share** and thereby **secure the large investments** that have been required to enter the SiC industry. **The growing competition in the market is already conspicuous in the IP landscape.**

Silicon Carbide Power Device Patent Landscape

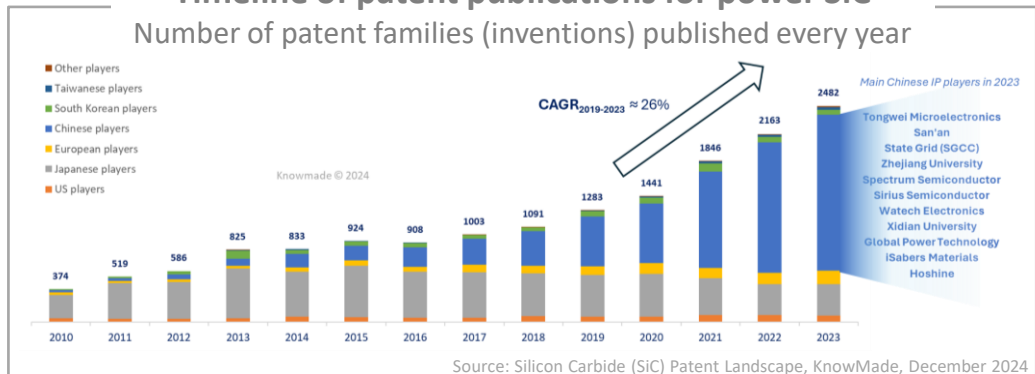
IP leadership of patent assignees



Geopolitical tensions between US and China have also triggered an **increase in patent filings**, accelerating the formation of local semiconductor ecosystems across the world, especially in **China**. In 2023, Chinese players were responsible for more than 70% of patent publications across the whole SiC supply chain, with an **impressive number of newcomers**, of which many companies involved in the SiC wafer industry. With such a high number of companies involved in SiC wafer developments, China has already succeeded in stopping the shortage situation but opened a period of economic instability for many suppliers due to a fierce price competition. **This new context may favor patent litigations between SiC wafer suppliers.**

Timeline of patent publications for power SiC

Number of patent families (inventions) published every year



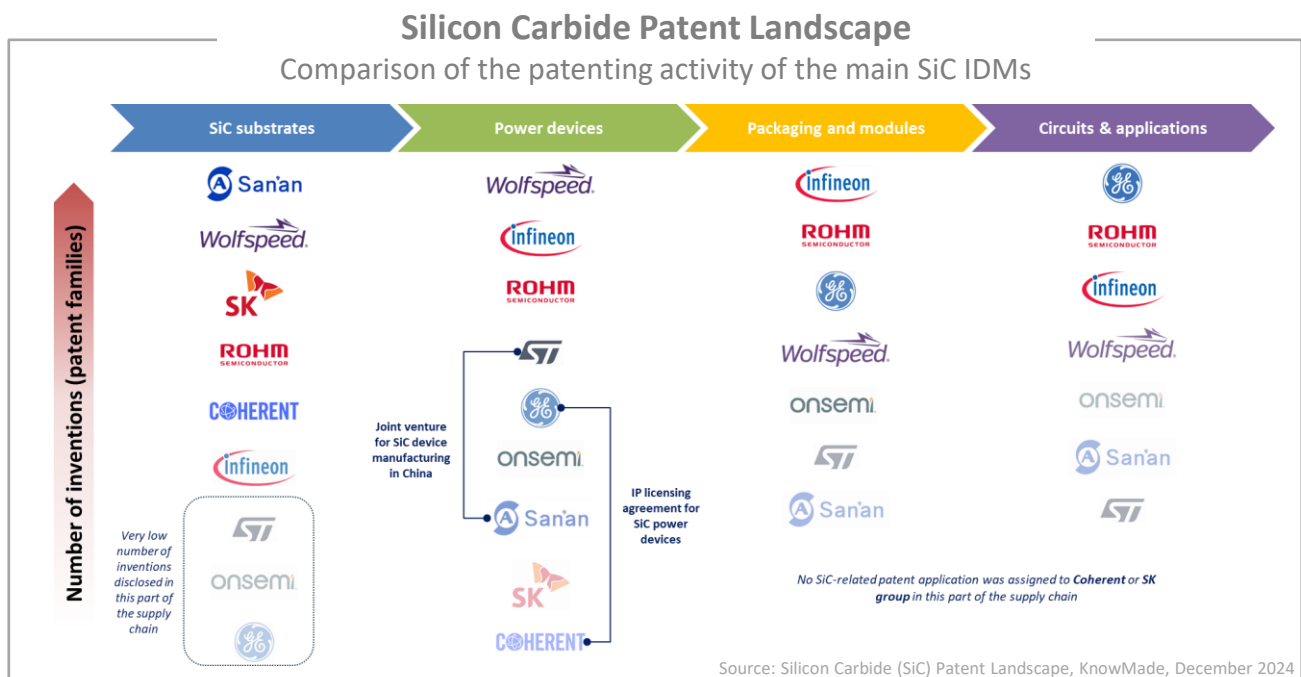
Patent landscape overview

The **first section** of the **Silicon Carbide (SiC) Patent Landscape report 2024** describes the **global patent competition across the SiC supply chain** by identifying the **main IP players** and **newcomers** and positioning their patent portfolios in each part of the SiC supply chain. The SiC patent portfolios are also analyzed geographically to highlight important markets in the **IP strategy of SiC companies**.

For **SiC power devices**, the patent analysis has been split into diodes, MOSFET and other SiC devices. What's more, for SiC MOSFET, the IP competitive analysis is available for **planar MOSFET** and **trench MOSFET** separately. It highlights the fact that most companies in the SiC patent landscape have integrated trench MOSFET in their technological roadmap, leading to an acceleration in patent filings in this area. As a result, trench MOSFET has become an increasingly competitive IP space in recent years.

Furthermore, **a special focus is made on China** which stands out by the explosion of the number of patent assignees in recent years, and an IP activity that is strongly dominated by domestic patent filings. Few players stand out by filing patent applications outside China. Interestingly, due to the very high patenting activity in China, patent analysis has become very relevant to describe such a dense ecosystem and make it less opaque to global competitors.

Eventually, the patent analysis highlights the **IP activities of main market players**, which are facing strong competition from many players in this landscape. They are either future market competitors, future integrators of SiC devices such as automotive Tiers-1 and OEM, or even potential suppliers (SiC equipment, materials). Indeed, patents may also be instrumental in negotiations and partnerships across the future SiC supply chain.



IP profiles of key players

The **second section** of the **Silicon Carbide (SiC) Patent Landscape report 2024** focuses on the IP activities of **main SiC device market players and/or companies investing significantly into building a vertically-integrated infrastructure for SiC**. Such companies have adopted an IDM business model and look to integrate within the company every step of SiC manufacturing, from material growth, to device manufacturing and packaging. Interestingly, the comparison of their IP activities highlights quite differentiated IP strategies. While certain companies heavily rely on patents to assert their position in the market, other companies have not significantly developed their patent portfolio across the SiC supply chain. Regarding the geographic distribution of patent filings, there are also some discrepancies between players, showing the relative importance of the different markets for each company (US, Japan, Europe, China, South Korea and Taiwan).

This patent analysis provides a **complete overview of the SiC patent portfolios** held by **Wolfspeed, Infineon, onsemi, Rohm, SK, STMicroelectronics, Coherent** (and its licensor **General Electric**) and **San'an**. By focusing on the recent patenting activities of such players, it is possible to detect small signals, such as involvement in new technological areas (e.g., superjunction structures, trench MOSFET), or a strong IP activity in new regions. As such, it may provide some indications regarding the strategic plans of the company. Eventually, this review of the latest patent publications details the recent evolutions of SiC technology at every level of the supply chain.

Useful Excel patent database Patent database

This report includes an extensive **Excel database with the 19,000+ patent families** (inventions) analyzed in this study, including **patent information** (numbers, dates, assignees, title, abstract, etc.) and **hyperlinks to an updated online database** (original documents, legal status, etc.), and **segments** (bulk SiC, epitaxial SiC substrates, SiC diodes, planar SiC MOSFETs, trench SiC MOSFETs, SiC modules, circuits, etc.). Additionally, the Excel file comprises the **complete data by assignee** from the statistical analyses, including the number of patent families, timeline of patenting activity, number of granted patents and pending patent applications, and geographical coverage of patent portfolio.

Companies mentioned in the report (non-exhaustive)

Mitsubishi Electric, Sumitomo Electric, Denso, Fuji Electric, Toyota Group, Hitachi, Infineon, Toshiba, Rohm, Resonac, Panasonic, Wolfspeed, SICC, CETC, Nissan, State Grid (SGCC), General Electric, San'an, LG Corporation, CRRC, ABB, Hyundai, Siemens, Global Power Technology, Shindengen Electric Manufacturing, STMicroelectronics, CEC, FerroTec Holdings, Synlight Crystal, Onsemi, Bosch, Disco, Kansai Electric Power (KEPCO), TankeBlue, SK group, Tongwei Microelectronics, Midea, BASiC Semiconductor, TYSiC - Tianyu Semiconductor Technology, PN Junction Semiconductor, iSabers Materials, Spectrum Semiconductor, Shin-Etsu, KY Semiconductor, Sanken Electric, Gree Electric Appliances, Century Goldray (CENGOL), Sharp, Kyocera, Watech Electronics, Sirius Semiconductor, Huawei, Proterial (Hitachi Metals), Senic, Toyo Tanso, Shanghai Hestia Power, Coherent, YASC - Anhui Yangtze Advanced Semiconductor, GlobalWafers, BYD, Northrop Grumman, Microchip Technology, EpiWorld, Volkswagen Group, Sumitomo Metal Mining, JRC - Japan Radio, Semikron Danfoss, Chongqing Wattscience Electronic Technology, Hoshine, Power Integrations, Meidensha Electric Manufacturing, StarPower Semiconductor, United Nova Technology (UNT), Soitec, Delta Electronics, ZF, Guangzhou Summit Crystal Semiconductor (GZSC), Jiangsu Jixin Advanced Materials, Xiner, Huaxinwei Semiconductor Technology (Beijing), Semisouth Lab, Beijing Microcore Technology, Hypersics Semiconductor, SiCentury, Macrocore Semiconductor, Daikin Industries, Nissin Electric, Raytheon Technologies, NCE Power, etc.

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ABOUT KNOWMADE

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