

Silicon carbide substrate costs falling as larger diameters adopted

Number of 8-inch SiC fabs under construction or planned globally reaches 11.

With the continuous surge in demand for silicon carbide (SiC) substrates in recent years, the call for cost reduction in SiC has been growing stronger, as the ultimate product price remains the key determinant for consumers, says market research firm TrendForce.

The cost of SiC substrates accounts for the highest proportion of the entire cost structure, reaching about 50%. Cost reduction and utilization rate improvement in the substrate segment are hence particularly crucial. Large-size substrates, due to their cost advantages, are therefore gradually being adopted, with high expectations.

Chinese SiC substrate maker TankeBlue Semiconductor calculates that upgrading from 4-inches to 6-inches can reduce costs by 50% per unit, and upgrading from 6-inches to 8-inches can cut costs by an additional 35%.

Meanwhile, 8-inch substrates can yield more chips, resulting in lower edge wastage. In simple terms, 8-inch substrates offer a higher utilization rate, which

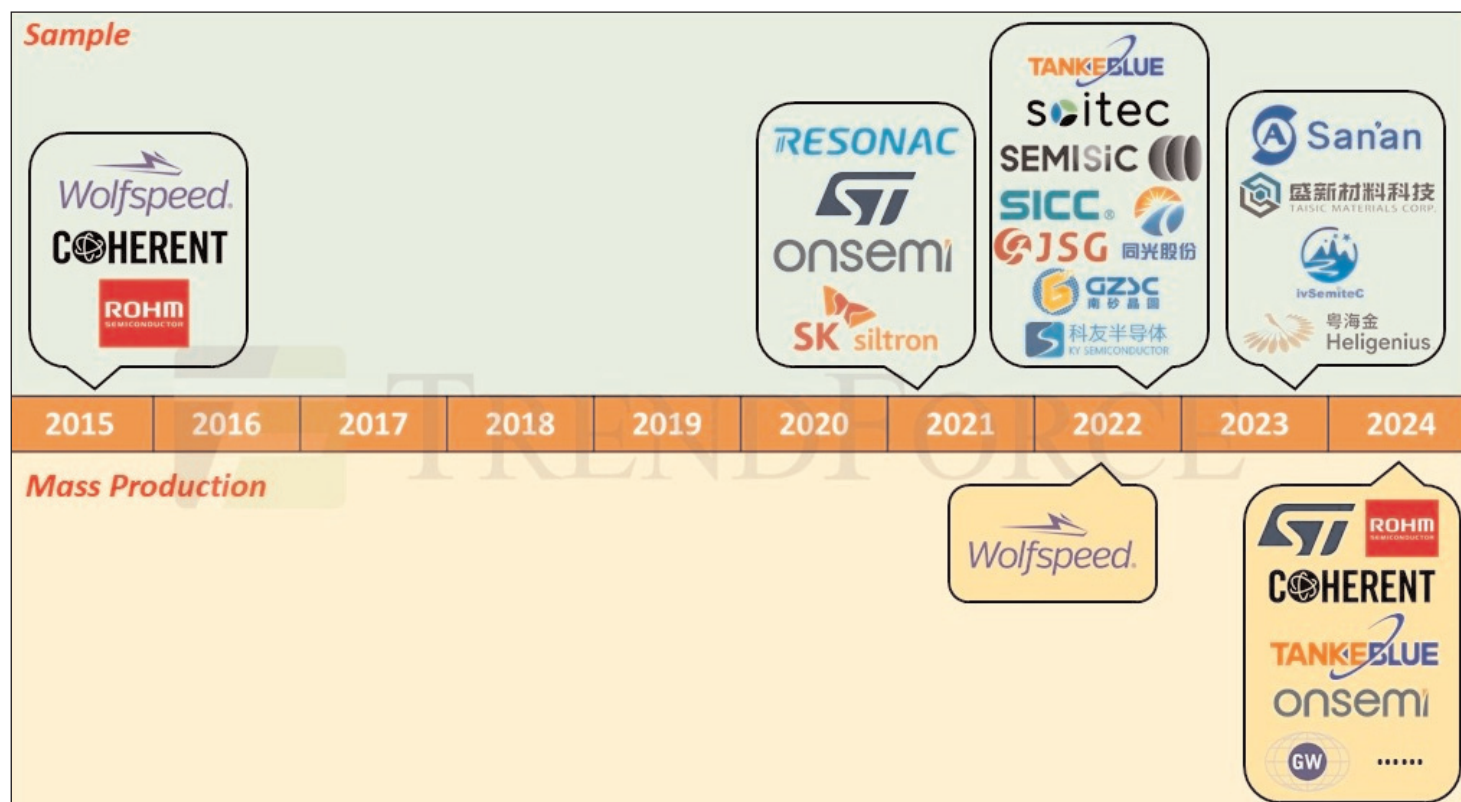
is the main reason why major manufacturers are actively developing them.

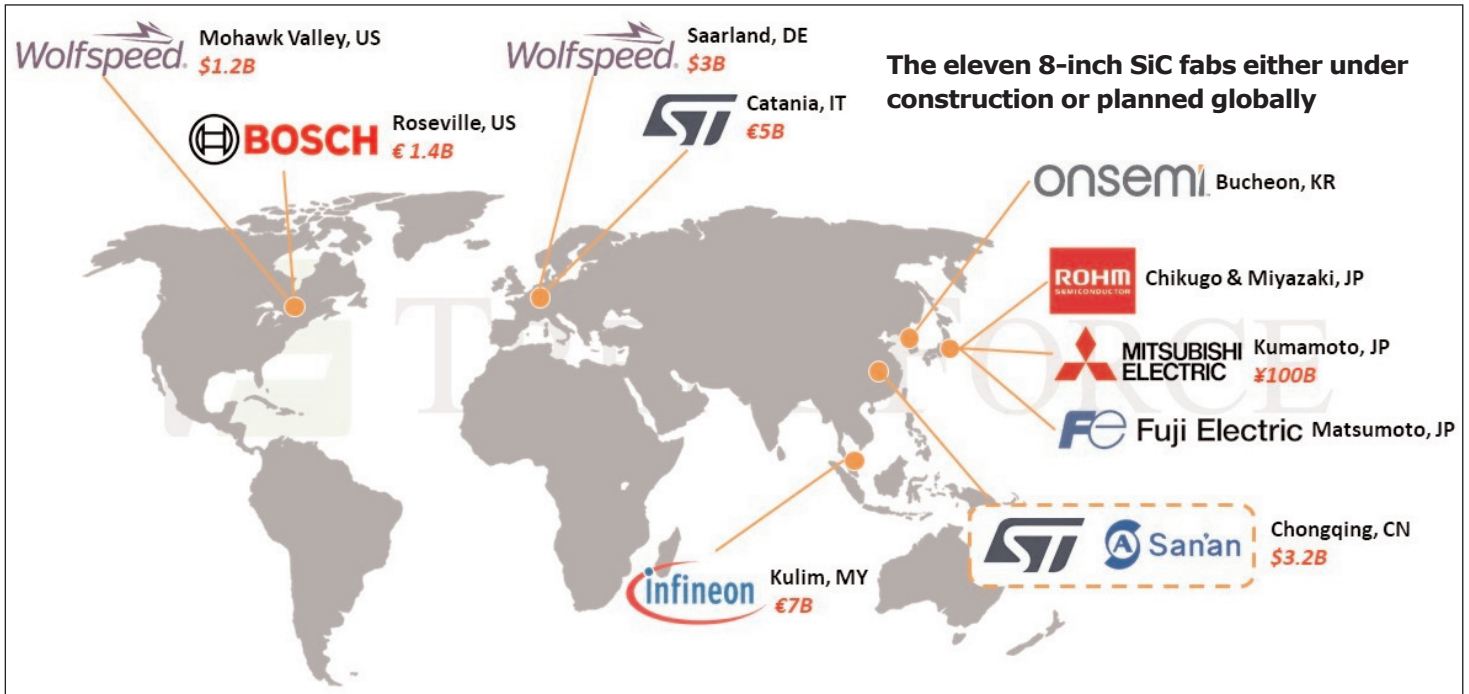
Currently, 6-inch SiC substrates are still dominant, but 8-inch substrates are beginning to penetrate the market. For example, in July 2023 Wolfspeed announced that its 8-inch fab had begun shipping SiC MOSFETs to Chinese customers, indicating its bulk shipment of 8-inch SiC substrates. TankeBlue has also started small-scale shipments of 8-inch substrates, with plans to achieve medium-scale shipments by 2024.

Accelerated advancement of 8-inch SiC substrate lineup

Since Wolfspeed first showcased samples in 2015, the 8-inch SiC substrate has undergone a development history of 7–8 years, with significant acceleration in technology and product development in the past two years.

Apart from Wolfspeed, which has achieved mass production, there are seven firms that are expected to





achieve mass production of 8-inch SiC substrates this year or in the next 1–2 years.

In terms of investment, Wolfspeed continues to construct the John Palmour Silicon Carbide Manufacturing Center (SiC substrate facility) in North Carolina, USA. This facility will further drive the expansion of substrate production capacity to meet the increasing demand for 8-inch wafers.

Coherent also announced plans last year to expand its production of 8-inch substrates and epitaxial wafers, with large-scale expansion projects in the USA and Sweden. In terms of product export channels, Coherent has received a \$1bn investment from Mitsubishi Electric and Denso to provide long-term 6/8-inch SiC substrates and epitaxial wafers to both companies.

Europe-based STMicroelectronics also invested in the 8-inch domain last year by partnering with Hunan Sanan Semiconductor to construct an 8-inch SiC wafer fab in China. The latter will accompany it by establishing an 8-inch SiC substrate plant, ensuring a stable supply of material for the joint venture. Simultaneously, ST is developing its own substrates and previously collaborated with France-based Soitec to achieve mass production of 8-inch SiC substrates.

Regarding Chinese manufacturers, currently over 10 enterprises have entered the sampling and small-scale production stages for 8-inch SiC substrates. These include companies such as Semisic Crystal Co, Jingsheng Mechanical & Electrical Co, SICC Co, Summit Crystal Semiconductor Co, Synlight Semiconductor Co, TanKeBlue Semiconductor Co, Harbin KY Semiconductor, IV Semitec, Sanan Semiconductor, Hypersics, and Yuehaijin Semiconductor Materials Co.

In addition, many other Chinese manufacturers are currently researching 8-inch substrates, such as GlobalWafers, Dongni Electronics, Hesheng Silicon

Industry, and Tiancheng Semiconductor.

At present, the gap between Chinese substrate manufacturers and the international giants has narrowed significantly. Companies like Infineon have established long-term partnerships with Chinese manufacturers such as SICC Co and TanKeBlue. From a technological standpoint, this narrowing gap reflects the overall improvement in substrate technology globally. Moving forward, concerted efforts from various manufacturers are expected to drive the development of 8-inch substrate technology.

Overall, there is a growing momentum in the overall development of 8-inch SiC substrates, with significant breakthroughs in both quantity and quality.

Global 8-inch SiC fabs accelerate expansion

As substrate materials continue to break through technological ceilings, the global increase in the number of new 8-inch SiC fabs reached new heights in 2023.

According to TrendForce, about 12 expansion projects related to 8-inch wafers were implemented in 2023. Among them, eight were led by global manufacturers such as Wolfspeed, Onsemi, STMicroelectronics, Infineon, Rohm, and others. STMicroelectronics also collaborated with Sanan Semiconductor on one project. Additionally, three projects were spearheaded by Chinese manufacturers such as Global Power Technology, United Nova Technology Co, and J2 Semiconductor.

From a regional perspective, significant investments in new 8-inch SiC fabs are expected in key regions such as Europe, America, Japan, South Korea, China, and Southeast Asia. As of now, there are about 11 8-inch fabs either under construction or planned globally.

These include two facilities by Wolfspeed (in Mohawk, NY, USA, and Saarland, Germany), one by Bosch (in Roseville, USA), one self-built by STMicroelectronics

(in Catania, Italy), one joint venture with Sanan (in Chongqing, China), one by Infineon (in Kulim, Malaysia), one by Mitsubishi Electric (in Kumamoto, Japan), two by Rohm (in Chikugo and Kunitomi, Japan), one by ON Semiconductor (in Bucheon, South Korea), and one by Fuji Electric (in Matsumoto, Japan).

Regarding the direction of expansions by manufacturers, the investments by Bosch and ON Semiconductor in 2023 are directly aimed at the automotive SiC market. STMicroelectronics' planned 8-inch SiC chip factory in Italy also targets the electric vehicle market. While other manufacturers have not explicitly stated the targeted applications for future production capacity, electric vehicles are the primary growth engine for SiC both currently and in the future, making it a focal point for expansion among major manufacturers.

In the electric vehicle sector, the 800V high-voltage platform has emerged as a clear development trend. The 800V platform requires higher-voltage power

semiconductor components, prompting manufacturers to begin developing 1200V SiC power devices.

From a cost perspective, although 6-inch wafers are currently mainstream in the short term, the trend towards larger sizes like 8-inch is inevitable for cost reduction and efficiency improvement purposes.

The electric vehicle market is therefore expected to drive continuous growth in demand for 8-inch wafers in the future.

From a supply chain perspective, transitioning to 8-inch wafers represents a breakthrough for SiC manufacturers. According to industry insights, the 6-inch SiC device market has entered a phase of intense competition, particularly in the SiC junction barrier diode (JBD). For smaller-scale and less competitive enterprises, profit margins are increasingly squeezed, indicating an impending round of consolidation and restructuring in the future. ■

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