

China's automotive SiC market will be valued at RMB12.99 billion

Device On resistance: 1/200 Size: 1/10 Si MOSFET SIC MOSFET System www.researchinchina.com Energy loss: <1/4 Switching Recovery loss Si IGBT SIC MOSFET Source: ROHM



1. In 2025, China's automotive SiC market will be valued at RMB12.99 billion, sustaining AAGRs of 97.2%.

Silicon carbide (SiC) devices that feature the resistance to high voltage and high frequency are seen more and more in new energy vehicles. At present, SiC devices are often used in main drive inverters, OBCs (on-board chargers), DC-DC vehicle power converters and highpower DCDC charging equipment. With compact dimensions, SiC devices can reduce much power loss for new energy vehicles and thus make them still work normally at a high temperature of 200°C. The miniature and lightweight SiC devices can also lessen the energy consumption caused by the weight of a vehicle itself.



On one estimate, China demands around RMB1.69 billion worth of automotive SiC substrates in 2022. Thanks to the growing new energy vehicle market and wider adoption of SiC products, China's automotive SiC substrate market will be valued at RMB12.99 billion in 2025, showing AAGR of 97.2%. SiC substrates are replacing more automotive Sibased IGBTs. From the cost structure (substrate 46%, epitaxial wafer 23%, and module 20%) of SiC devices, it can be seen that China's new energy vehicle SiC device market will be worth RMB28.24 billion in 2025.

China's New Energy Vehicle SiC Substrate Market Size, 2022-2025E





In 2018, Tesla first installed 24 SiC power modules (provided by STMicroelectronics) in the main inverter of Model 3, with supported voltage of 350-400V. The SiC power modules used in Model 3 can bring a 5-8% increase in the efficiency of the inverter compared with the IGBT modules in Model S, that is, the inverter efficiency gets improved from 82% to 90%, enabling a much longer cruising range. After Tesla Model 3 used SiC modules, other automakers including Toyota, BYD, NIO, GM, Volkswagen and Renault-Nissan-Mitsubishi have followed suit.

As OEMs head for 800V high-voltage platforms, silicon carbide becomes more in demand, and the pace of using it in vehicles quickens. From 2021 to 2022, foreign models such as Hyundai IONIQ5, Audi e-tron GT and Porsche Taycan, and Chinese models like Great Wall Saloon Mecha Dragon, BAIC ARCFOX α S Huawei Inside (HI) Edition and ZEEKR 001 have been the first ones to pack 800V high-voltage platforms. 800V and SiC become the best partners.

More new energy vehicles based on 800V architectures will be production-ready beyond 2023. To answer the needs for high current and high voltage, the main drive inverter of motor controllers will be bound to replace Si-based IGBTs with SiC-MOS. According to Infineon's forecast, by 2025, over 20% of power devices for automotive electronics will use SiC technology.

	Automaker	Vehicle Model	Battery Voltage	Inverter Technology	Time To Market
	Tesla	Model 3	350-400V	SIC MOSFET	2018
	Toyota	Miral (FCEV)	310V	SIC MOSFET	2020
	Tesla	Model Y	351-400V	SIC MOSFET	2020
	Tesla	Model S (2021)	350-400V	SIC MOSFET	2021
	Tesla	Model X (2021)	351-400V	SIC MOSFET	2021
Globa I	Ford	Mach E	450V	SIC MOSFET	2021
	Hyundai	IONIQ 5	800V	SIC MOSFET	2021
	Audi	e-tron GT	800V	SIC MOSFET	2021
	Porsche	Taycan	800V	SIC MOSFET	2022
	GM	Ultium	800V	SIC MOSFET	2022
	Mercedes-Benz	EVA	800V	SIC MOSFET	2023
	Porsche	Macan	800V	SIC MOSFET	2023
	BYD	Han	570V	SIC MOSFET	2020
China	Great Wall Saloon	Mecha Dragon Limited Edition	800V	SIC MOSFET	2021
	BAIC ARCFOX	ARCFOX aS Huawei Inside (HI) Edition	800V	SIC MOSFET	2022
	ZEEKR	001	800V	SIC MOSFET	2022
	BYD	ocean-x	800V	SIC MOSFET	2022
	Xpeng Motors	G9	800V	SIC MOSFET	2022
	Lotus Cars	Type132	800V	SIC MOSFET	2023
	Li Auto		800V	SIC MOSFET	2023~
	Leapmotor		800V	SIC MOSFET	2024~

SOP of SiC Modules for Some Global and Chinese Vehicle Models

Source: ResearchInChina



SiC suppliers are the busiest players in the run-up to a boom in demand.

Foreign companies:

STMicroelectronics: since 2018, the demand from Tesla has facilitated a surge in orders for STMicroelectronics' 650V SiC MOSFETs. In June 2022, the vendor invested USD244 million to build a new SiC production line in Morocco for exclusive supply to Tesla.

Bosch: from October 2021 to July 2022, Bosch invested a total of EUR800 million to expand its semiconductor capacity and SiC clean rooms, hoping to become the world's leading supplier of SiC chips for electric mobility.

ON Semiconductor: since 2021, ON Semiconductor has provided inverter SiC modules for a Mercedes-Benz EQ fleet. It will also provide SiC products for Mercedes-Benz VISION EQXX concept car (SOP in 2024). Based on its optimistic estimates of the market, ON Semiconductor established a new research center and a wafer fabrication plant in Bucheon, Gyeonggi-do, Japan in July 2022. The vendor predicts that its SiC products will contribute revenues of USD1 billion in 2023 and USD2.6 billion in 2024.

Chinese companies:

BYD Semiconductor: in June 2022, BYD Semiconductor introduced a 1200V 1040A SiC power module, delivering nearly 30% higher power without changing the original package dimensions. According to BYD's plan, by 2023 all EVs under it will use SiC power semiconductors instead of Si-based IGBTs.

San'an Optoelectronics: in June 2021, its semiconductor base in Hunan became operational, providing silicon carbide used in onboard chargers for BYD. In addition, in February 2022, San'an Optoelectronics and Li Auto established a joint venture to research silicon carbide technologies and expand the silicon carbide market.

Synlight Semiconductor: on December 29, 2021, Synlight Semiconductor and Great Wall Motor signed a strategic investment agreement, under which Synlight Semiconductor will provide SiC products for Mecha Dragon models of Great Wall Motor. The subsequent range of models will largely use SiC products as well.



Product Layout of Some Global and Chinese SiC Companies

Supplier		Headq uarter s	SiC Product Layout						
			Substrate				Epit	Devi ce	Major
			Size	SOP	Capacity	Applicatio n in Vehicles	l Waf er	and Modu le	Client
Foreign	ON Semiconduc tor	USA	6 inches, 8 inches	2021		Inverter	\checkmark	\checkmark	Mercedes- Benz
	Wolfspeed	USA	8 inches	Apr. 2022		Inverter, on-board charger	\checkmark	\checkmark	GM
	STMicroelect ronics	Switze rland	8 inches	2023		Inverter, on-board charger	v	\checkmark	Tesla, Renault- Nissan- Mitsubishi Alliance
	Infineon	Germa ny	8 inches	2023		I <mark>nve</mark> rter, on-board charger	~	\checkmark	Hyundai
	Bosch	Germa ny	6 inches	Invested EUR800 Electric million from Oct. drive 2021 to Jul. 2022 system		Electric drive system		\checkmark	
Chinese	TankeBlue	Beijing	6 inches	Aug. 2020	120k pcs/year	Inverter			Huawei
	AccoPower	Guang zhou	6 inches	May 2021		Inverter		\checkmark	Geely
	San'an Optoelectro nics	Fujian	6 inches	Jun. 2021	360k pcs/year	Inverter	\checkmark	\checkmark	BYD, Li Auto
	Weixin Changjiang	Anhui	4 inches, 6 inches	Aug. 2021	250k pcs/year	Inverter		\checkmark	
	Synlight Semiconduc tor	Hebei	4 inches, 6 inches	Aug. 2021	100k pcs/year	Inverter			Great Wall Motor
	SICC	Shand ong	6 inches	Jul. 2022	300k pcs/year	Inverter			Xpeng Motors, SAIC, GAC
	StarPower Semiconduc tor	Zhejia ng	6 inches	2024	60k pcs/year	Inverter		\checkmark	Yutong Bus

Source: ResearchInChina

Through the lens of layout of suppliers, there are still big differences between Chinese companies and their foreign peers:

- 1. Foreign companies have achieved mass production of 6-inch substrates and are deploying 8-inch products; Chinese companies are in the 4 to 6-inch phase.
- 2. 2. The foreign industry chain is more complete. For example, Wolfspeed, ON Semiconductor, STMicroelectronics and the like have built a vertical supply system of "SiC substrate-epitaxial wafer-device-module", while Chinese players still stay at one link in the industry chain.

In the future, to meet market demand and gain more competitive edges, Chinese suppliers need to solve issues like industry chain expansion, R&D of automotive-grade SiC MOSFETs, batch manufacturing capacity, and yield improvement in addition to construction of production lines.



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Beijing Headquarters TEL: 010-82601561, 82863481 FAX: 010-82601570 Email: report@researchinchina.com

Website: www.researchinchina.com

WeChat: zuosiqiche



Chengdu Branch

TEL: 028-68738514 FAX: 028-86930659



