

Longer range as standard: Bosch gives go-ahead for volume production of silicon carbide chips

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- ④ Harald Kroeger: “We want to become a global leader in the production of SiC chips for electromobility.”
- ④ Silicon carbide semiconductors enable longer ranges and faster recharging for electric cars.
- ④ Volume production to begin in December 2021. Bosch has been producing SiC chips for customer validation since the beginning of 2021.

Reutlingen, Germany – They are small, powerful, and extremely efficient: semiconductors made of silicon carbide (SiC). After several years of development, Bosch is now starting volume production of power semiconductors made of this innovative material, supplying automotive manufacturers worldwide. In the future, more and more production vehicles will feature these chips. “The future for silicon carbide semiconductors is bright. We want to become a global leader in the production of SiC chips for electromobility,” says Harald Kroeger, member of the board of management of Robert Bosch GmbH. Two years ago, the supplier of technology and services had announced that it would push ahead with the development of SiC chips and enter production. For this, Bosch has developed its own highly complex manufacturing processes, which it has been using to produce the special semiconductors since the beginning of 2021 – initially as samples for customer validation. “Our order books are full, thanks to the boom in electromobility,” Kroeger says. In the future, Bosch intends to expand its production capacity for SiC power semiconductors to a unit volume running into the hundreds of millions. With this in mind, the company has already started expanding the clean-room space at its Reutlingen plant. In parallel, work is also being done on the second generation of SiC chips, which will be even more efficient and should be ready for volume production as of 2022. Bosch is receiving support for the development of these innovative manufacturing processes for SiC semiconductors from the German Federal Ministry for Economic Affairs and Energy (BMWi) as part of the “Important Project of Common European Interest (IPCEI) Microelectronics” program. “For several years now, we have been providing support to help establish semiconductor production in Germany. Bosch’s highly innovative semiconductor production strengthens the microelectronics ecosystem in Europe and is a further step

toward greater independence in this key field of digitalization,” says Peter Altmaier, Germany’s Federal Minister for Economic Affairs.

The stuff range dreams are made of

Around the world, demand for silicon carbide power semiconductors is rising. A forecast by the market research and consulting company Yole indicates that, between now and 2025, the SiC market as a whole will grow on average by 30 percent a year to over 2.5 billion dollars. At around 1.5 billion dollars, the SiC car market is expected to account for the lion’s share. “Silicon carbide power semiconductors make particularly efficient use of energy. This material’s advantages really come to the fore in energy-intensive applications such as electromobility,” Kroeger says. In the power electronics of electric vehicles, silicon carbide chips ensure that drivers can drive significantly further on one battery charge – on average around 6 percent further than with their pure silicon counterparts. In order to meet steadily increasing demand for these semiconductors, an extra 1,000 square meters were already added to the clean-room space at the Bosch wafer fab in Reutlingen in 2021. Another 3,000 square meters will be added by the end of 2023. The new space will house state-of-the-art production facilities for manufacturing silicon carbide semiconductors using processes developed in-house. To achieve this, Bosch’s semiconductor experts are building on their decades of expertise in chip manufacturing. In the future, the company – incidentally the only automotive supplier to produce its own silicon carbide chips – plans to manufacture the semiconductors on 200-millimeter wafers. Compared with today’s 150-millimeter wafers, this will deliver sizeable economies of scale. After all, it takes several months for a single wafer to pass through several hundred process steps in countless machines. “By producing on larger wafers, we can manufacture significantly more chips in one production run and thus supply more customers,” Kroeger says.

Small atom, big impact

The secret behind SiC chips’ impressive performance lies in a tiny carbon atom. Introducing it into the crystalline structure of the ultra-pure silicon generally used to manufacture semiconductors gives the raw material special physical properties: for example, silicon carbide semiconductors support higher switching frequencies than pure silicon chips. What’s more, they lose only half as much energy in the form of heat, thereby increasing the range of electric vehicles. The chips are also important for 800-volt systems, where they enable faster recharging and better performance. Since the SiC chips also emit significantly less heat, the power electronics require less in the way of costly cooling. In addition to weight, this is another way to reduce the cost of electric vehicles. In the future, Bosch will supply silicon carbide power semiconductors to customers around the world – both as individual chips and installed in power electronics or complete solutions such as the e-axle. This combination of electric motor, gearbox, and power electronics achieves an efficiency of up to 96 percent thanks to the more

efficient design of the overall system. This leaves more energy for the powertrain, which increases the range.

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