Automotive market growth is reshaping the SiC market’s dynamics and ecosystem.

**WHAT’S NEW**
- Updated market size for:
  - Discrete diodes, diodes in hybrid modules, discrete transistors, and full SiC modules
  - Diode and transistor bare-die market
  - Revised voltage analyses of SiC power devices: 650V, 1200V, 1700V, and 1700V+
  - Current SiC wafer and SiC epiwafer market
  - Updated player status, with a focus on China
  - Discussion of recent M&A events, key players’ competitive advantages, and the market’s dynamics

**KEY FEATURES**
- A deep understanding of SiC’s penetration in different applications, including xEV, xEV charging infrastructure, PFC/power supply, PV, UPS, motor drives, wind, and rail
- Review of state-of-the-art SiC-based devices, modules, and power stacks, with product charts for each
- Description of SiC power’s industrial landscape (from materials to systems)
- SiC power device market-value projections to 2024, including bare die market with transistor/diode split, device market split by application, and device market with discrete/module split
- Deep analysis of the SiC power market’s dynamics
- SiC power device voltage analysis
- Market value and volume projections for the SiC wafer and epiwafer markets, through 2024
- SiC power industry roadmap

**POWER SIC 2019: MATERIALS, DEVICES, AND APPLICATIONS**

**Market & Technology Report - July 2019**

**DRIVEN BY THE EV MARKET, THE SiC POWER DEVICE MARKET IS PROSPERING**

The 2018 - 2019 SiC power device market is notable for Tesla’s adoption of SiC in its main inverter. The discussion concerning whether other automotive players will also adopt (or not) is THE topic of the year. Recently, the automotive industry has committed more than $300B investment towards xEV development, causing the xEV market to explode. This is in stark contrast to the traditional combustion engine car market, which is suffering through a slowdown. The xEV market is the primary market driver for Si power devices, and it is the source of excitement for SiC - which is not surprising at all.

Ranging from conservative to optimistic, industrial players offer very different forecasts in terms of market value for SiC in the xEV market. These forecasts range from several hundred million dollars to $3B in 2025, the latter estimated by STMicroelectronics. Everyone agrees that EV is the market of highest potential, but perceptions differ regarding how it will grow and how SiC will penetrate into the automotive market. These perceptions are based on the data that each player has collected and the arguments that derive from their interpretation of the data.

Based on our discussions with different players, Yole sees a prospering SiC power device market. In fact, we expect the SiC power semiconductor market’s value to approach $2B by 2024, with a compound annual growth rate (CAGR) of 29% for 2018 - 2024. The automotive market is undoubtedly the foremost driver, and as such will hold around 50% of total device market share in 2024.

This report provides an overview of various SiC power device markets, including electric and hybrid electric vehicles (EV/HEV), charging infrastructure, PV, power supply, rail, motor drives, uninterruptible power supplies (UPS), and wind, along with Yole Développement’s analysis and insights regarding SiC adoption.

**AUTOMOTIVE MARKET GROWTH IS RESHAPING THE SiC MARKET’S DYNAMICS AND ECOSYSTEM**

In the Si world, power modules are typically used for high power-rating applications (i.e. EV main inverter and rail), while discrete modules are employed for lower power-rating applications. As indicated in the illustration below, some players (i.e. Infineon) participate in both the discrete and module sides, while other players (i.e. Danfoss and Semikron) are pure module packagers. There are also discrete packagers, among them several different OSATs.

Just like in Si IGBT, for SiC we expect the module to play a key role. But what form will a full SiC
WILL THE WAFER SHORT-SUPPLY CONTINUE?

In the last two or three years, the transition from 4” to 6” wafers, coupled with increasing wafer demand, led to a wafer short-supply. This was one of the most frequently discussed topics in the SiC power industry, and was a substantial bottleneck as of 2018.

Faced with increasing demand, wafer players are investing heavily. Already the SiC wafer market leader, Cree is further strengthening its leadership. The company has announced $450M for materials expansion and the development of a materials megafactory, as well as build-out of a module take? Even though some manufacturers use standard silicon packaging, most players have developed their own module for SiC. For example, the SiC device used by Tesla: it is either a very small module or an advanced discrete, depending on your interlocutor.

From our understanding, Tesla has succeeded in structuring its SiC supply chain with its own module-design intellectual property, which was co-developed with STMicroelectronics and Boschman - with STMicroelectronics manufacturing the devices. As volume increases, we believe there will be a second packaging source, likely an OSAT in Asia that in the past was more of a discrete player. Indeed, the automotive market is not only driving the SiC power device market, it is also refashioning the market’s dynamics and ecosystem. The influence is profound.

This report provides an overview of SiC device technology, including descriptions of discrete and module development, along with the status of commercial products and their reliability. We also furnish a comprehensive summary of the SiC power industry, covering the entire value chain: from material to epitaxy to module. Moreover, this report outlines Yole Développement’s understanding of the market’s current dynamics and future evolution.

**2018 SiC wafer market share estimation*: Wolspeed, a Cree company**

![Diagram of SiC wafer market share estimation]

*Non exhaustive list of companies

*(Yole Développement, July 2019)
second crystal-growth factory. These steps will result in a 30x increase in SiC wafer fabrication in fiscal year 2024, compared to Q1 of fiscal year 2017. With different long-term wafer supply agreements in place, Cree has secured important revenue that its materials business can use in the coming years. But Cree is not the only player investing - other companies like II-VI and Tankeblue are following suit, and some new players are very active, especially GTAT. In our opinion, the wafer suppliers' efforts have paid off, and supply is in much better shape for 2019.

At the epiwafer level, the situation is also evolving quickly. For example, we have seen Showa Denko expand its capacity in 2015, 2016, and 2018, as technology matures and outsourcing ratio increases.

We invite you to explore our analysis of the wafer supply situation, as well as our forecasts for the wafer and epiwafer markets and the impact of different investments.

REPORT OBJECTIVES
- Provide a clear understanding of the SiC power industry, covering markets from wafer to discrete and module-level, with valuations in units and $M
- Analyze the SiC power industry’s market drivers and bottlenecks by studying SiC’s adoption in different end-applications and supply chains
- Summarize of the status of SiC power device technology
- Describe the industry’s landscape and market dynamics

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Alstom, Ascatron, Aymont, Bombardier, Basic Semiconductor, Brückwell Technology, Caly Technology, Class-SiC Wafer Fab, CREE, CRRC, Danfoss, Delphi, DENSO, Dow Corning, Episil, Fraunhofer IISB, Fuji Electric, GE, GeneSiC, Global Power Device, Global Power Technology, Hestia Power, Hitachi, IBS, II-VI, Infineon, MicroSemi, Mitsubishi Electric, Norstel, Northrop Grumman, NXP, ON Semiconductor, Panasonic, Philips, Powerex, Raytheon, RENESAS, ROHM, Sanrex, Schneider Electric, Semikron, Shindengen, SICC, Siemens, SMA, STMicroelectronics, Toshiba, Toyota, United Silicon Carbide, WeEn, Wolfspeed, X-Fab, Yaskawa, and more.

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The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

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