



FOR IMMEDIATE RELEASE:

Automotive is driving SiC adoption

Extracted from: Power SiC 2018: Materials, Devices and Applications report, Yole Développement – Release date: July 2018 | Tesla Model 3 Inverter with SiC Power Module from STMicroelectronics report, System Plus Consulting – Release date: June 2018.

LYON, France – July 5, 2018: The SiC¹ power market is now on the road, asserts [Yole Développement \(Yole\)](#). Therefore, since 2017, the market research and strategy consulting company identified more than 20 strategic announcements, showing the dynamism of this market and attractiveness of the technology. Rohm, Bombardier, Cree, SDK, STMicroelectronics, Infineon Technologies, Littelfuse, Ascatron and more are part of the powerful ecosystem, presenting innovative products and revealing key partnerships and/or M&A².

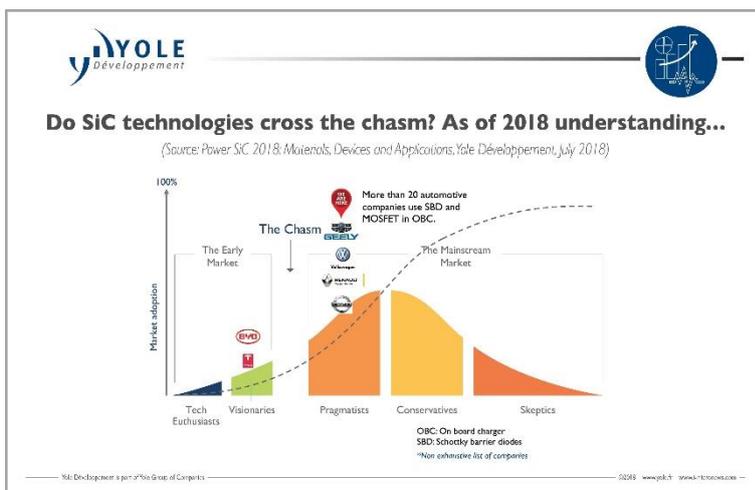
Today, SiC transistors are clearly being adopted, penetrating smoothly into different applications. Yole's analysts forecast a US\$1.4 billion SiC power semiconductor market by 2023. According to the Power & Wireless team at Yole, this market is showing a 29% CAGR³ between 2017 and 2023.

[Power SiC report, 2018 edition](#) presents Yole's deep understanding of SiC penetration in different applications including xEV, xEV charging infrastructure, PFC/power supply, PV, UPS, motor drives, wind and rail. In addition, it highlights the state-of-the-art SiC-based devices, modules, and power stacks. Yole's analysts also describe the SiC power industrial landscape from materials to systems, and analyze of SiC power market dynamics. This report proposes a detailed

quantification of the SiC power device market until 2023, in value and volume.

SiC adoption is accelerating: is the supply chain ready? Yole's analysts reveal today their vision of the SiC industry.

SiC market is still being driven by diodes used in PFC⁴ and PV⁵ applications. However Yole expects that in five years from now the main SiC device market driver will be



¹ SiC: Silicon Carbide

² M&A: Mergers and acquisitions

³ CAGR : Compound Annual Growth Rate

⁴ PFC : Power Factor Correction

⁵ PV : photovoltaic

transistors, with an impressive 50% CAGR for 2017-2023. This adoption is partially thanks to the improvement of the transistor performance and reliability compared to the first generation of products, which gives confidence to customers for implementation.

Another key trend revealed by Yole's analysts is the SiC adoption by automotive players, over the next 5-10 years. "Its implementation rate differs depending on where SiC is being used," comments **Dr. Hong Lin, Technology and Market Analyst, Compound Semiconductors at Yole**. "That could be in the main inverter, in OBC⁶ or in the DC/DC converter. By 2018, more than 20 automotive companies are already using SiC SBDs⁷ or SiC MOSFET⁸ transistors for OBC, which will lead to 44% CAGR through to 2023."

Yole expects SiC adoption in the main inverter by some pioneers, with an inspiring 108% market CAGR for 2017-2023. This will be possible because nearly all carmakers have projects to implement SiC in the main inverter in coming years. In particular, Chinese automotive players are strongly considering the adoption of SiC.



The recent SiC module developed by STMicroelectronics for Tesla and its Model 3 is a good example of this early adoption. The SiC-based inverter, analyzed by [System Plus Consulting](#), Yole's sister company is composed of 24 I-in-I power modules. Each module contains two SiC MOSFETs with an innovative die attach solution and connected directly on the

terminals with copper clips and thermally dissipated by copper baseplates. The thermal dissipation of the modules is performed thanks to a specifically designed pin-fin heatsink.

"SiC MOSFET is manufactured with the latest STMicroelectronics technology design," explains **Dr. Elena Barbarini, Head of Department Devices at System Plus Consulting**. "This technical choice allows reduction of conduction losses and switching losses". STMicroelectronics is strongly involved in the development of SiC-based modules for the automotive industry. During its recent Capital Markets Day, the leading player details its activities in this field (Source: [Automotive & Discrete Group presentation](#) – May 2018). STMicroelectronics is also committed in the development of innovative packaging solutions. . System Plus Consulting proposes today [a complete teardown analysis](#)

⁶ OBC : On-Board Charger

⁷ SBD : Schottky barrier diodes

⁸ MOSFET : Metal-Oxide Semiconductor Field-Effect Transistor

including a detailed estimation of the production cost of the module and its package.

PV has also caught the attention of Yole's analysts during recent months. China claimed almost the half of the world's installations in the last year. However due to new governmental regulations, Yole sees a PV market slowdown in short term and has lowered its expectation of SiC penetration for the segment. In general, system manufacturers are interested in implementing cost effective systems which are reliable, without any technology choice, either silicon or SiC.

"Today, even if it's certified that SiC performs better than silicon, system manufacturers still get questions about long term reliability and the total cost of the SiC inverter", comments **Dr. Ana Villamor, Technology & Market Analyst, Power Electronics & Compound Semiconductors at Yole.**

Full collection of compound semiconductors and power electronics reports on is available on i-micronews.com.

Yole and System Plus's teams will attend [SEMICON Europa 2018](#) (Munich, Germany – November 13-16). During the leading trade show, **Dr. Milan Rosina, Senior Technology & Market Analyst, Power Electronics & Batteries at Yole** proposes a dedicated WBG presentation on November 15 at 2:30 PM. SiC and GaN⁹ devices have demonstrated their large potential for power electronic applications. During the presentation "GaN and SiC power device: market overview" taken place during the Power Electronics Session, Dr. Rosina proposes an overview of the market, technology and the industrial supply chain. More information available on i-micronews.com, [Conferences & Trade Shows section](#).

⁹ GaN : Gallium Nitride

ABOUT THE REPORTS:**POWER SiC 2018: MATERIALS, DEVICES AND APPLICATIONS**

Automotive is putting SiC on the road. Is the supply chain ready? – Produced by Yole Développement (Yole).

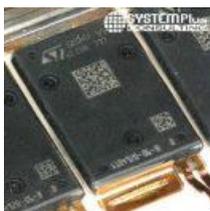
Companies cited in the report:

ABB, Alstom, Ascatron, Aymont, Bombardier, Basic Semiconductor, Brückwell Technology, Caly Technology, Clas-SiC wafer fab, Cree, CRRC, Danfoss, Delphi, DENSO, Dow Corning, Epiworld, 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... [Full list](#)

Authors:

Dr. Hong Lin and Dr. Ana Villamor, all part of the Power & Wireless division at Yole Développement co-authored the Power SiC 2018: Materials, Devices and Applications report:

- **Dr. Hong Lin** works as a Technology and Market Analyst, Compound Semiconductors since 2013. She is specialized in compound semiconductors and provides technical and economic analysis. Before joining Yole Développement, she worked as R&D engineer at Newstep Technologies. She was in charge of the development of cold cathodes by PECVD for visible and UV lamp applications based on nanotechnologies. She holds a Ph.D in Physics and Chemistry of materials.
- **Dr. Ana Villamor** serves as a Technology & Market Analyst, Power Electronics & Compound Semiconductors. She is involved in many custom studies and reports focused on emerging power electronics technologies at Yole Développement, including device technology and reliability analysis (MOSFET, IGBT, HEMT, etc). In addition, Ana is leading the quarterly power management market updates released in 2017. Previously Ana was involved in a highadded value collaboration related to SJ Power MOSFETs, within the CNM research center for the leading power electronic company ON Semiconductor. During this partnership and after two years as Silicon Development Engineer, she acquired a relevant technical expertise and a deep knowledge of the power electronic industry. Ana is author and co-author of several papers as well as a patent. She holds an Electronics Engineering degree completed by a Master in micro and nano electronics, both from Universitat Autònoma de Barcelona (SP).

**TESLA MODEL 3 INVERTER WITH SiC POWER MODULE FROM STMICROELECTRONICS**

The first SiC power module in commercialized electric vehicles – Produced by System Plus Consulting

This report is a complete teardown with detailed photos, precise measurements, material analysis, manufacturing process flow, supply chain evaluation, manufacturing cost analysis, selling price estimation and a detailed comparison with Mitsubishi J-Series TP-M power module... [Full description](#)

Authors:

- **Dr. Elena Barbarini** is the responsible of Device's Department at System Plus Consulting and she is in charge of costing analysis of Power Electronics and Semiconductors Compounds. . She has a deep knowledge of Electronics R&D and Manufacturing environment. Elena holds a Master in Nanotechnologies and a PhD in Power Electronics.
- **Véronique Le Troadec** has joined System Plus Consulting as a laboratory engineer. Coming from Atmel Nantes, she has extensive knowledge in failure analysis of components and in deprocessing of integrated circuits.

ABOUT SYSTEM PLUS CONSULTING

System Plus Consulting specializes in the cost analysis of electronics, from semiconductor devices to electronic systems. Created more than 20 years ago, System Plus Consulting has developed a complete range of services,



costing tools and reports to deliver in-depth production cost studies and estimate the objective selling price of a product. System Plus Consulting engineers are experts in Integrated Circuits – Power Devices & Modules – MEMS & Sensors – Photonics – LED – Imaging – Display – Packaging – Electronic Boards & Systems. Through hundreds of analyses performed each year, System Plus Consulting offers deep added-value, reports to help its customers understand their production processes and determine production costs. Based on System Plus Consulting's results, manufacturers are able to compare their production costs to those of competitors. System Plus Consulting is a sister company of Yole Développement (Yole). More info. on www.systemplus.fr

ABOUT YOLE DEVELOPPEMENT



Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide covering MEMS & Sensors - Imaging - Medical Technologies - Compound Semiconductors - RF Electronics - Solid State Lighting - Displays - Photonics - Power Electronics - Batteries & Energy Management - Advanced Packaging - Semiconductor Manufacturing - Software & Computing - Memory and more...

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. . For more information, visit www.yole.fr and follow Yole on [LinkedIn](#) and [Twitter](#).

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