GaN & SiC Devices

GaN & SiC for power electronics applications report

SiC and GaN will compete with silicon from low to high power

KEY FEATURES OF THE REPORT

- Description of the applications where GaN and SiC can be used, including PFC, EV/HEV, PV, UPS, Motor Drive, Wind, Wireless Power, Envelop Tracking, Lidar
- Projections for GaN lateral device and SiC power device markets up to 2020
- Roadmaps for WBG technology and its main remaining challenges
- Description of WBG power device industry landscape and the players in it
- Detailed description of SiC implementation in EV/HEV
- Yole Développement's vision on GaN and SiC

REPORT OUTLINE

- GaN and SiC for power electronics applications report
- PDF & Excel file
- €5,990 – Multi user license (170+ slides)
- €4,990 – One user license (170+ slides)
- July 2015

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THE SiC MARKET IS EXPECTED TO TREBLE AND GaN IS EXPECTED TO EXPLODE - IF CHALLENGES ARE OVERCOME

In 2014, the SiC chip business was worth more than $133M. As in previous years, power factor correction (PFC) and photovoltaics (PV) are still the leading applications.

SiC diodes represent more than 80% of the market. In 2020, diodes will remain the main contributor across various applications, including electric and hybrid electric vehicles (EV/HEV), PV, PFC, wind, Uninterruptible Power Supplies (UPS) and motor drives.

SiC transistors will grow in parallel with diodes, driven by PV inverters. Challenges must be overcome prior to the adoption of pure SiC solutions for EV power train inverters, which is nevertheless expected by 2020.

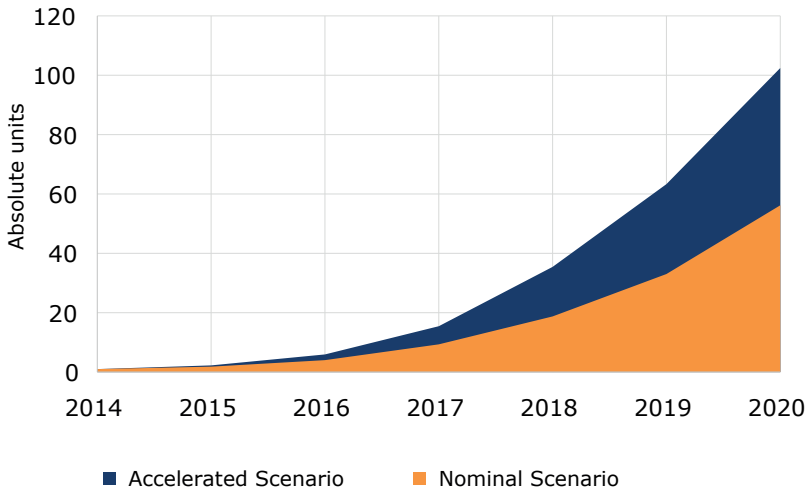
Including the growth in both diodes and transistors we expect the total SiC market to more than treble by 2020, reaching $436M.

GaN potentially has a huge Total Accessible Market (TAM), and its adoption would therefore be significant.The starting point and the growth rate are directly linked to two important questions:

- How will the emerging applications of low voltage GaN expand and how GaN will be adopted by these applications?
- Will 600V devices make their way into market?

Yole Développement has integrated these variables in developing two scenarios for the GaN device market up to 2020. The analysis is based on the penetration rate of GaN in different applications including DC-DC conversion, Lidar, envelope tracking, wireless power, and PFC... We estimate the GaN device market size will be $303M in 2020 in the nominal scenario. In the accelerated scenario, where low voltage GaN and 600V GaN are rapidly adopted, the figure for 2020 is $560M. Emerging applications, namely envelope tracking, wireless power and Lidar, together will consume one third of GaN transistors. In both scenarios low voltage applications below 200V are expected to be the major contributors to the market. We invite you to read the report to find out more.

GaN device market size: Nominal vs accelerated scenario



(Yole Développement, July 2015)

COMPANIES ARE MOVING IN THE RIGHT DIRECTION TO OVERCOME THE REMAINING TECHNICAL CHALLENGES TO ACCELERATE ADOPTION OF WBG DEVICES.

Designing a totally new product with these semiconductors will induce R&D expenses that have to be compensated by adding value at the system level. This could include improving cost, size, and operating condition compared to regular silicon solutions. To grab this added value an integrator has to get the full benefit from Wide Band Gap (WBG) devices' increased operating frequency and temperature.

So far, the WBG market hasn't grown as fast as people in the business have hoped. The four barriers to WBG device adoption remain:

- High cost at the device level
- Reliability
- Multi-sourcing
- Integration

Many R&D programs have been launched in recent years. Some prototypes have demonstrated that the cost of the Bill Of Materials (BOM) can be lower at the system level when using WBG devices.

To overcome reliability challenges, ROHM and Cree have announced new SiC device generations or platforms with enhanced, more stable, specifications. SiC and GaN devices are also going through reliability tests to lower their adoption risk.

Numerous companies have now developed SiC MOSFETs, including Cree, Rohm, ST Microelectronics, Mitsubishi and GE. This means end users are better able to multi-source these devices. By contrast, there's a limited number of suppliers in the GaN market. In coming years, new entrants like ExaGaN and TSMC will provide extra sourcing options. Infineon and Panasonic also announced in 2015 that they would establish a dual-sourcing relationship for normally-off 600V GaN power devices.

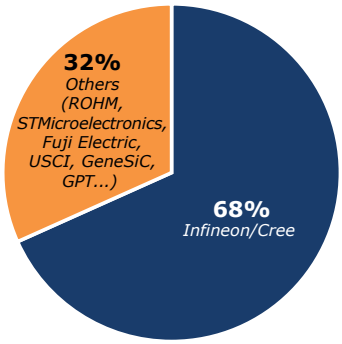
Integrating these fast switching, high operating temperature devices remains one of the major challenges. WBG suppliers and end users need to reconsider many factors, including device packaging, module packaging, gate driver integration and topology design.

Packaging is becoming a particular bottleneck, but the good news is that companies are moving in the right direction. GaN device makers EPC and GaN Systems have both adopted advanced packaging, which seems to be more suitable than traditional power device packages. The recent acquisition of APEI by Cree will likewise accelerate the development of SiC module packaging.

Read more about the challenges facing WBG in the full report.

RECENT FINANCIAL MOVES INDICATE MARKET CONFIDENCE IN WBG DEVICES

Market share of SiC device makers in 2014



(Yole Développement, July 2015)

There have recently been several pieces of good news for the WBG business. The current SiC device market leader Cree decided to spin off its power and RF division as a separate company, and will issue shares in a new IPO. We interpret this announcement as a positive sign of the continuing growth in the SiC power device market.

At the same time, around $100M in investments have been made in different GaN startups, as indicated in the following table. Two of them are in the top four commercial GaN companies. These investments reflect the confidence in the GaN device market and investors' willingness to provide funds to accelerate production capabilities.

Company name	Investment	Date
GaN Systems	$20M	May 2015
Exagan	$6.5M	June 2015
Transphorm	$70M	June 2015

WILL GAN AND SIC COMPETE FOR THE SAME POWER ELECTRONICS APPLICATIONS?

After years of discussion about whether it would be GaN or SiC, the answer is now clearer than ever.

SiC diodes have existed on the market for over 14 years, and are becoming a mature technology, leaving no room for GaN diodes.

GaN transistors have made their way into low voltage applications, which SiC will find difficult to challenge.

Commercial SiC transistors exist in the 600-3300 V range. Compared to GaN lateral devices, their advantages at voltages over 1200 V are now widely recognized. In early 2015, SiC device leader Cree launched its 900 V platform. This is considered by the market as a significant move for SiC, signaling its intention to address 900 V and lower voltage applications.

GaN is also trying to enter the 600 V market. Applications such as PFC, on-board chargers, and low voltage-high voltage DC-DC converters for automotive will therefore be the main battle fields for GaN and SiC in the coming years.

In the end, integrators do not care what the chips they buy are made of. They want suitable devices at reasonable prices to make a system desired by the market. The real competition is not between GaN and SiC, but WBG versus incumbent silicon-based technology. Silicon IGBT technology is progressing, becoming better and cheaper. In the future, the market will not be as dominated by silicon-based devices as it is today, but more diversified. A collection of devices, including silicon, GaN, SiC and others that are yet to be developed, will find their own niches.

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