SiC and GaN for Power Electronics: Two Markets Driven by Different Growth Engines

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OUTLINE

• About Yole Group
• Power Electronics introduction
• Power SiC
  • Market forecasts.
  • Application trends.
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About Yole Group
YOLE GROUP’S MAJOR ACTIVITIES PER ENTITY

Market, technology, and strategy consulting
M&A and evaluation of companies
Direct access to the analysts

Technology, process & cost analysis
Teardown and reverse engineering
Comparative analysis

Characterization of electro-optical performances and risks
Specification, design and industrialization of systems
YOLE GROUP : FIELDS OF EXPERTISE COVERING THE SEMICONDUCTOR INDUSTRY

- Semiconductor Packaging
- Semiconductor Manufacturing
- Memory
- Computing and Software
- Photonics & Lighting
- Imaging
- Sensing & Actuating
- Display
- Radio Frequency
- Compound Semiconductors
- Power Electronics
- Batteries
- Electronic Systems
- Emerging Technologies

Power & Wireless Division

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180+ collaborators in 9 different countries
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REPORTS
Insight
› Yearly reports
› Market, technology and strategy analysis
› Supply chain changes analysis
› Reverse costing and reverse engineering

Format
› PDF files with analyses
› Excel files with graphics and data

Topics
› Photonics, Imaging & Sensing
› Lighting & Displays
› Power Electronics & Battery
› Compound Semiconductors
› Semiconductor Manufacturing and Packaging
› Computing & Memory

115+ reports per year

MONITORS
Insight
› Quarterly updated market data and technology trends in units, value and wafer
› Direct access to the analyst

Format
› Excel files with data
› PDF files with analyses graphs and key facts
› Web access (to be available soon)

Topics
› Advanced Packaging
› Application Processor
› DRAM & NAND
› Compound Semiconductor
› CMOS Image Sensors
› Micro-controller
› Semiconductor Test Equipment

7 different monitors quarterly updated

TRACKS
Insight
› Teardowns of phones, smart home, wearables and automotive modules and systems
› Bill-of-Materials
› Block diagrams

Format
› Web access
› PDF and Excel files
› High-resolution photos

Topics
› Consumer: Smartphones, smart home, wearables
› Automotive: Infotainment, ADAS, Telematics

205+ teardowns per year Daily updates

CUSTOM SERVICES
Insight
› Specific and dedicated projects
› Strategic, financial, technical, supply chain, market and other semiconductor-related fields
› Reverse costing and reverse engineering

Format
› PDF files with analyses
› Excel files with graphics and data

Topics
› Photonics, Imaging & Sensing
› Lighting & Displays
› Power Electronics & Battery
› Compound Semiconductors
› Semiconductor Manufacturing and Packaging
› Computing & Memory

190 custom projects per year

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A UNIQUE AND PROVEN METHODOLOGY

MARKETING EXCELLENCE AND BEST-IN-CLASS NETWORK

- Market segmentation
  - Per application
  - Per technical needs
  - Per technology adoption and supply chain’s tendencies
- Primary research and direct interviews with key players

“Thanks to its unique semiconductor market intimacy, its understanding of the industrial environment and its vision on future technologies adoption, Yole Group supports its customers at every stage of their growth”

BOTTOM-UP, TOP-DOWN AND INDUSTRIAL EXPERTISE

- Top-down
  - End market demand analysis
  - Market forecasts at system and component levels down to wafer and equipment
- Bottom-up
  - Ecosystem analysis
  - Consolidate industrial players’ revenue at component, module and system levels
- Industrial experts in all our fields of investigation

STATE-OF-THE-ART TECHNOLOGY AWARENESS

- Technology analysis
  - Competitive landscape and technology comparison
  - Reverse costing
  - Reverse engineering
- Technology life cycle
  - Development cycles
  - Supply chain adoption
  - HV manufacturing and evolutions
- Performance testing and analysis
A WIDE RANGE OF INFORMATION SOURCES

Our unique position allows us to obtain detailed and accurate information.

- 20+ years in the semiconductor industry
- 120+ annual conferences
- 5,000 players interviews per year
- 1250+ teardown tracks available
- 6,800+ companies’ news relayed
- 100+ analysts worldwide

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Power Electronics Introduction
THREE MAIN DRIVERS FOR POWER MARKET GROWTH

Electrification  
Efficiency  
Sustainability

Electricity Consumption ↑  
Energy Consumption ↓  
Energy Generation ↑  
CO₂ ↓
TRANSITION HISTORY – POWER DEVICES

1970 ... 2000 2010 2020 2030

Time

Manufacturing automation, electrification

Industri

Mobile & Consumer

Automotive & Mobility

Incentive mechanisms driving renewables & efficiency

Post-COVID

ICE car auxiliaries

Government incentives & ICE bans

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SiC AND GaN WILL REPRESENT MORE THAN 30% OF THE POWER MARKET IN VALUE BY 2028!

Main market drivers:

Silicon devices include Rectifiers, thyristors, bipolar, X-FETs such as MOSFETs and JFETs, IGBTs, and modules and IPMs. 
Source: Power SiC/GaN Market Monitor Q2-23
POWER SiC
**SiC DEVICE MARKET TO NEARLY REACH $9B BY 2028**

Automotive applications dominate the SiC market due to strong electrification trend, by presenting 70% of the Power SiC market in 2022.

Power SiC device market is forecast to grow nearly to $9B with continuing penetration of SiC in automotive, along with industrial

Source: Power SiC 2023 report
We distinguish between SiC diodes and SiC transistors. SiC diode dies are packaged into discrete packaging. They are also used as anti-parallel diodes in so-called hybrid modules with silicon-based transistors, mainly IGBTs, as well as anti-parallel diodes in full SiC modules with SiC transistors, mainly SiC MOSFETs.

SiC transistor bare dies are packaged into discrete packaging or used to make full SiC modules.

In consequence, there are four types of devices sold on the market:
1. Discrete SiC diodes.
2. Discrete SiC transistors.
3. Hybrid modules: as market value comes from both SiC and silicon-based semiconductors, we count only the contribution from bare die SiC diodes so as not to introduce bias into our market estimation.
4. Full SiC modules, both with and without anti-parallel diodes.
Full SiC modules are expected to dominate the SiC market, mainly driven by the xEV inverter and other high-power applications. And discrete SiC transistors will gain momentum in OBC, EV chargers, and industrial power supply.
GLOBAL XEV VOLUME FORECAST

BEVs will have the biggest growth, followed by PHEVs. HEVs will be stable, still mainly Japanese OEMs. MHEVs are gaining popularity thanks to their lower cost premium compared to ICE. FCEV will have no meaningful volumes for light-duty vehicles.

Data extracted from Yole report “Power Electronics for e-Mobility 2023 – Focus on passenger & light commercial vehicles”. For more details, please refer to that report.

- Battery Electric Vehicle is the biggest market in terms of units and value ($M).
- Passenger car electrification is growing faster than previously expected and will continue growing with a double-digit CAGR between 2022 and 2028.
Overview of xEVs

**CO₂ emissions compared to thermal vehicles (in %)**

*CO₂ emission in car operation

- **Thermal vehicle (ICE)**
  - 100%
  - 300-100 gCO₂/km

- **48V mild-hybrid EV (MHEV)**
  - 50%
  - 130-90 gCO₂/km
  - No battery charging from the grid

- **Full HEV**
  - 1-3 kWh
  - 170 gCO₂/km

- **PHEV**
  - Battery charging from the grid
  - 10-20 kWh
  - 9-120 kWh
  - 70-30 gCO₂/km

- **BEV**
  - Battery charging from the grid
  - 0 kWh
  - 0 gCO₂/km

- **FCEV**
  - Battery charging from the grid
  - 9-120 kWh
  - 70-350 kW

**ICE taken as a reference**

**Battery energy capacity**
**Traction (main) inverter average power**

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* Yole Intelligence presentation

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**Level of electrification**

**Battery energy capacity**
**Traction (main) inverter average power**

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* Yole Intelligence presentation
WHICH OEMs HAVE CHOSEN SiC ALREADY?

Drivers and markets for SiC

Requirements
- Efficiency: long range & minimize battery costs.
- Size: small-size, low-weight, easier integration.
- Reliability: automotive qualified devices.
- Thermal: thermal dissipation in high power.

Drivers for SiC
- High efficiency, compact design, easy to integrate, minimal cooling, low switching losses, higher efficiency at low load.
- SiC - for inverters in premium cars with 400V and 800V batteries.
- SiC - in onboard chargers.
- SiC – in high-end sports EVs for performance and system downsizing.
- SiC in BEVs is poised to grow, especially in the 800V BEV segment.
## SIC DESIGN-WIN MATRIX AS OF Q2-2023

Leading SiC device players’ design-wins at OEMs

| OEM | SiC device | TESLA | HYUNDAI | STELLANTIS | VOLKSWAGEN | Mercedes-Benz | JAGUAR | LAND ROVER | VOLVO | GM | NIO | XPENG | LUCID | BMW |
|-----|------------|-------|---------|-----------|------------|---------------|--------|------------|-------|----|-----|-------|-------|-------|-----|
| CT  | In-motion  | ✓     | ✓       | ✓         | ✓          |                |        |            |       |    |     |       |       |       |     |
| Infineon |            | ✓     | ✓       | ✓         | ✓          |                |        |            | ✓     |    |     | ✓     |       |       |     |
|   |            | ✓     | ✓       | ✓         | ✓          | ✓              |        | ✓          | ✓     |    |     | ✓     | ✓     | ✓     |     |
| Wolfspeed |            | ✓     | ✓       | ✓         | ✓          | ✓              |        | ✓          | ✓     |    |     | ✓     | ✓     | ✓     |     |
| ROHM |            | ✓     | ✓       | ✓         | ✓          | ✓              |        | ✓          | ✓     |    |     | ✓     | ✓     | ✓     |     |

- As of 2023, major OEMs are looking for double-sourcing SiC devices for their current and future models to be released.
- It’s a non-exhaustive list.
- The information is based on Yole’s understanding, sources from press releases and industry feedback.

**Inverter**

**OBC & DC-DC**
800V BATTERY SYSTEM ARRIVED IN 2021

More OEMs to adopt SiC

Some automotive OEMs launched 800V battery EV models or platforms to enable high-power fast charging, which is limited by complex connector design under high current. 1200V SiC devices are the enabler for this feature.

2019/2020: first 800V system Porsche Taycan

BYD continues the sales of its high-end Han EV equipped with 1.2kV SiC. In Sept. 2021, BYD launched e-Platform 3.0, supporting an 800V battery.

Hyundai launched its first 800V EV, Ioniq 5, in 2021. It’s based on Hyundai’s 800V platform, E-GMP.

In Nov. 2021, Lucid air delivered its 900V EV.

And more to come!

1200V SiC devices are the enabler for this feature.

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650V-rated device

1200V-rated device

(check the detailed content for more insights and data points)
POWER SiC SUPPLY CHAIN AND BUSINESS MODELS AT A GLANCE

- SiC Boule/Substrate
- SiC Epitaxy
- Chip Processing
- Diode/Transistor Design
- Module Packaging
- System

*Showa Denko, the leading SiC epiwafer supplier, is currently Resonac.

*Non-exhaustive list

As of 2023, BYD outsources epiwafers.
WHO ARE THE LEADERS IN SiC WAFER AND DEVICE MARKETS?

Wolfspeed

53%

Wolfspeed

19%

Coherent

19%

53%

$333M → +66% → $554M

$1.1B → +71% → $1.88B

37%

19%

16%

14%

7%

2021

2022

$333M

$554M

$1.1B

$1.88B

Yole Intelligence
### Notable Acquisitions and Partnerships in 2022-2023 (Q3)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Wafer</th>
<th>Epiwafer</th>
<th>Chip Process</th>
<th>Module</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M&amp;A</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Veeco</strong></td>
<td><strong>€425M</strong>*</td>
<td><strong>$30M</strong>*</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Navitas</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>$100M</strong>*</td>
<td></td>
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</tr>
</tbody>
</table>

*The amounts could include different scenarios, cash, share exchanges and additional conditions.*

In the past year, there’re multiple impactful M&A and partnerships announced in Power SiC eco-system.
IN 2027, MAJOR SiC PLAYERS’ 8” SiC FACILITIES

MHV fab: $1.2b
Saarland: $3b
Kumamoto: $750M
Chikugo
Kulim fab: $2b (including GaN)

Catania: €730M
SiC SUBSTRATE DEVELOPMENT TIMELINE

Is 8” the game changer?

Non-exhaustive list
DEMAND VS CAPACITY

The massive building-up in wafer capacity, especially the new entrants in China

Wafer capacity expansion likely to lead to price reduction of SiC wafers. Actual volume of wafer production does not consider quality and yield. Soon, vertical integration may not be so important for 4” and 6”.
POWER SiC KEY PROCESSES AND CHALLENGES

Growth:
- Slow growth rate and high temperature.
- Access to SiC seeds is critical.

Wafering:
- SiC is a hard material -> difficult to slice and polish.
- SiC substrates are prone to various defect types, proper polishing is required.
- Challenging surface defect inspection due to transparency and reflectivity of SiC wafer.
- Thicker wafers for 8” increases the cost.

Chip Processing:
- Difficult CMOS fab compatibility.
- High-temperature processes are required.
- Trench vs. planar:
  - The trench process is more complicated than planar. Several challenges, including difficulty controlling side wall roughness after etching due to SiC hardness.

Module Packaging:
- Novel ways of die attach, such as Ag or Cu sintering, and a new format of package for the new generation of devices are required for performance and reliability.

- SiC CVD tools require high temperatures, and the process is challenging and costly.
- High throughput and high run-to-run reproducibility is mandatory.
INNOVATIONS IN SiC WAFER TECHNOLOGY

Solutions targeting high added-value instead of lowering wafer ASP

SiC wafer is the core of the business. Various innovations have been proposed by many players to increase the value at the wafer level in the supply chain.
The choice of planar vs. trench depends on the performance of the device, company strategy, the target application, etc.

Trench devices enable lower Rdson and smaller size, but are more complex to make.
POWER GaN
In the next five years, Consumer applications continue to represent the biggest share and market driver for Power GaN devices. By 2028, it will account for more than 64% of the total market.

In the short/mid term, we expect “Automotive & Mobility” and “Telecom & Infrastructure” segments to be other growth engines for Power GaN market.

“Others” segment includes power supplies for medical applications and high-power (few kWs) ones for gaming and crypto-mining, and some R&D activities.
DIFFERENT TYPES OF GAN DEVICES

GaN-based ICs include two different topologies:

Discrete GaN HEMT

- Discrete GaN-on-Si HEMT
- Discrete GaN-on-Sapphire HEMT

Cascode device with Si MOSFET are considered as discrete

GaN-on-Si SiP

- GaN active layers
- Buffer layers
- Silicon substrate
- Si driver

GaN-on-Sapphire SiP

- GaN active layers
- Buffer layers
- Sapphire substrate
- Si driver

GaN-on-Si IC SoC

- GaN active layers
- Buffer layers
- Silicon substrate

GaN-on-Sapphire SoC

- GaN active layers
- Buffer layers
- Sapphire substrate

Silicon substrate

Buffer layers

GaN active layers

GaN driver

Cascode device with Si MOSFET are considered as discrete
Different solutions provide flexibility to the end-users. HEMT discrete, SiP and SoC all have their advantages and challenges in terms of cost, complexity, and application-oriented considerations.

We expect all device types to co-exist in the forecasted period.

Source: Power GaN 2023 Report - Yole Intelligence
GAN FAST CHARGERS: SMALLER, FASTER AND MORE ECOLOGICAL

Competitive analysis: GaN vs. Si fast chargers

<table>
<thead>
<tr>
<th>Brand</th>
<th>Volume (cc)</th>
<th>Price/Power ($/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innergie</td>
<td>86 g</td>
<td>0.12</td>
</tr>
<tr>
<td>Apple</td>
<td>193 g</td>
<td>0.08</td>
</tr>
<tr>
<td>Lenovo</td>
<td>127 g</td>
<td>0.10</td>
</tr>
<tr>
<td>Aukey</td>
<td>92 g</td>
<td>0.18</td>
</tr>
<tr>
<td>Remax</td>
<td>200 g</td>
<td>0.10</td>
</tr>
<tr>
<td>Xiaomi</td>
<td>82 g</td>
<td>0.15</td>
</tr>
<tr>
<td>Xiaomi</td>
<td>100 g</td>
<td>0.12</td>
</tr>
<tr>
<td>Lenovo</td>
<td>93 g</td>
<td>0.11</td>
</tr>
<tr>
<td>Xiaomi</td>
<td>100 g</td>
<td>0.12</td>
</tr>
<tr>
<td>Xiaomi</td>
<td>100 g</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Desired corner

Samsung's 45W fast charger based on silicon
52x53x30 mm
Power density: 0.55 W/cm³

Samsung's 45W fast charger based on GaN
48x44x28 mm
Power density: 0.76 W/cm³

GaN chargers offer higher power densities

Xiaomi's 120W fast charger based on GaN
64x61x28 mm
Power density: 1.17 W/cm³

Xiaomi's 120W fast charger based on silicon
64x61x28 mm
Power density: 1.17 W/cm³

MDY-12-ED
MDY-13-ET

EP-TA845
EP-T4510
Consumer power supplies: GaN DESIGN WINS

**H1-22**
- realme GT Neo 3 150W
- Motorola Edge X30 68W
- vivo iQOO 9 Pro 120W
- nubia Red Magic 7 Pro 165W
- Anker 45W
- Samsung 120W
- Lenovo nubia 100W
- Slim Q nubia 150W
- Huakesheng ON 230W
- ONEPLUS
- InGreen
- HAGIBIS
- TOLL
- SHARGE
- Anker
- DJI

**H2-22**
- realme
- motorola
- vivo
- Anker
- UGREEN
- TOLL
- TOSS
- SHARGE

**H1-23**
- realme
- motorola
- vivo
- Anker
- UGREEN
- TOLL
- SHARGE

**In-box chargers**
- realme
- motorola
- vivo
- Anker
- UGREEN
- TOLL
- SHARGE

**Accessory chargers**
- realme
- motorola
- vivo
- Anker
- UGREEN
- TOLL
- SHARGE

Non-exhaustive list:
- MacBook Air M2 15" 70W (on option)
- Motorola X40 Pro 125W
- edge 40 and S30 Pro Pantone 65W
- iQOO 10 Pro 120W
- huakesheng 230W
- ONEPLUS
- InGreen
- HAGIBIS
- TOLL
- SHARGE
- Anker
- DJI

*YESvGaN-TRANSFORM-PowerElec PhD summer school 2023 - Yole Intelligence presentation*
GaN IMPLEMENTATION IN EV / HEV?

Higher density, higher efficiency, and potentially lower system cost.

OEM’s and Tier-1’s are working to commercialize GaN based automotive systems

OEMs interested or invested in GaN technologies

Who is next?
GaN IMPLEMENTATION IN DATACENTERS?

GaN-based systems achieve lower CO2 footprint and higher revenues.

Who is already on-board?

Source: GaN Systems
POWER GaN SUPPLY CHAIN AND BUSINESS MODELS AT-A-GLANCE

- Non-exhaustive list, including R&D
- Most GaN epihouses could also have GaN-on-sapphire capability.
- QST® substrates from Qromis and GaN-on-QST processed wafers are currently offered by ShinEtsu and VIS

Some GaN device players have in-house packaging design capability and rely on OSATs for high volume manufacturing

• EPC has an asset-light vertically integrated model working with Episil and VIS for FE, and internal epitaxy capabilities at Epi-Precision
Driven mainly by consumer power supply applications, Power GaN device market will grow with a 2022-2028 CAGR > 49%.

Source: Power GaN 2023 report
MORE THAN $4B INVESTMENT IN POWER GaN INDUSTRY

IDMs

Foundries

$750M

Silan士兰微电子

$23M

CRI Micro

$43M

InnoScience

$470M

Exagan

Navitas

$830M

Infineon

Fabless or fab-lite business model

Epitaxy business

$30M

Soitec

$10M

Samsung

$10M

AZUR SPACE

$73M

iGaN

$17M

AZUR SPACE

$73M

Intellectual Ventures World Workgroup

$15M

Navitas

$32M

CGD Cambridge Semiconductors

$2.7M

Wise Integration

$15M

VisIC Technologies

$35M

Mediatek

$115M

Yaskawa

$100M

Navitas Si control IC JV

$20M

GeneSiC

VDD Tech

$10M

Xiaomi

$30M

MEDIATEK

$4B+ announced for investment and M&A! Who is NEXT? Stay tuned!

• Non-exhaustive list
• IDM : Integrated device manufacturer

2019 2020 2021 2022 2023
Several solutions and Power GaN device types are commercially available.

Types of GaN HEMT
- D-mode and E-mode

Substrates and epitaxy
- GaN-on-Si or GaN-on-sapphire and other substrates

Device voltage
- 40V, 100V, 650V, 900V or >1200V

Discrete or Integrated
- SiP vs. SoC
- Single switch, multiple switches, multiple functions

Manufacturing
- 31 Gallium Ga
  - 69.72%
- 7 Nitrogen N
  - 14.01%

System

End-users

Reliability and standards
- JEDEC-JEP, AEC-Q101

What and how to measure? And do customers want more?
GaN-on-Si is the main platform as of 2023. Few players are considering GaN-on-Sapphire such as Power Integrations and most recently Transphorm.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>GaN-on-silicon</th>
<th>GaN-on-sapphire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal expansion mismatch</td>
<td>High creates tensile stress and causes defects requiring complex buffer layers</td>
<td>High but creates compressive strain, not detrimental to epitaxial quality</td>
</tr>
<tr>
<td>Lattice mismatch</td>
<td>High defect density</td>
<td>Less demanding on buffer layer</td>
</tr>
</tbody>
</table>
| Standard substrate size and scalability | Mainly 6" as of 2023  
Many players developing 8" | Mainly 6", Unlikely to move to 8"                                               |
| Integration aspects               | Suitable for integration, but isolation is an issue for SoC solutions at high voltages, due to a conductive silicon substrate | Suitable for monolithic integration  
No cross-talk issues, electric isolated substrate |
| Thermal conductivity of the substrate | ++                                                                         | +  
Larger area needed, the power level is also limited to below 200W                |
| Cost of substrate (6")           | $                                                                            | $-$-$                                                                        |
| Cost of epiwafer                  | $$$                                                                          | $                                                                            |
| Suppliers                         | Numerous GaN-on-Si epihouses, and some foundries                            | Many substrate suppliers, it can benefit from the LED industry                  |

- Due to differences in lattice parameters and thermal expansion coefficients, epitaxial growth on silicon vs. sapphire is very different.
- A thick buffer layer is needed to compensate for the significant lattice mismatch between GaN and silicon: usually more than 5µm. This thickness can be smaller in the case of GaN-on-sapphire: around 3µm. This thickness also reflects in the cost of epiwafer of these two technologies.
D-mode: Depletion mode

- GaN transistors are intrinsically D-mode, meaning a negative $V_{th}$ is needed to turn off the transistor. To have a normally-off device in the circuit to reduce power consumption, different approaches are applied to D-mode GaN devices.
  - Cascode
  - Direct gate-drive:

E-mode: Enhancement mode

- A normally-off GaN device, with a positive $V_{th}$, doesn't need a special circuit to close the channel. However, it requires a complex structure and processes on the gate, for example gate recess technology or metal or dielectric gates. As of 2023, more players have developed e-mode GaN technology.
DIFFERENT PACKAGING SOLUTIONS ARE AVAILABLE:

- SMD (DFN, QFN)
- Embedded die
- WLCSP (LGA/BGA)

TO

TOLL

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FUTURE AND EMERGING SOLUTIONS
Toward higher voltages and more integration

Note: the figure is to indicate the development status of each technology.
CONCLUSION AND OUTLOOKS
Outlook of Power SiC market

Strongly driven by automotive applications, Power SiC is expected to reach nearly $9B by 2028. More high power and industrial applications will keep growing the market in the long-term.
POWER GAN MARKET OUTLOOK

2022

- Consumer power supplies
- GaN-on-Sapphire
- GaN-on-Si

$182M

2028

- Consumer power supplies and other applications
- EVs/HEVs OBCs
- DC/DC conversion
- Datacenters
- GaN-on-Sapphire
- GaN-on-Si

$2.04B

2032

- Consumer power supplies and other applications
- Datacenters
- EVs/HEVs Inverters
- Industrial market
- GaN-on-GaN?
- GaN-on-QST?
- GaN-on-SOI?

New technology

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YOLE GROUP RELATED PRODUCTS

Reports

Power SiC 2023

Status of the Compound Semiconductor Industry 2022

Emerging Semiconductor Substrates 2023

GaN Power Transistor Comparison 2023

Power GaN 2023

Status of the Power Electronics Industry 2023

Power Electronics for e-Mobility 2023 – Focus on passenger & light commercial vehicles

SiC Transistor Comparison 2023
YOLE GROUP RELATED PRODUCTS

Teardown Tracks

Consumer - Phone

Consumer - Smart Home

Consumer - Wearable

Consumer - Tablet, Computing & Gaming

Automotive - ADAS

Automotive - Electrification

Automotive - Infotainment

Automotive - Telematics

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OUR CS MONITOR OFFERS – DIRECT AND UNLIMITED ACCESS TO ANALYST

- Market forecast for devices, wafers and epiwafers (revenue, shipments, ASP)
  - market segment including automotive, consumer, telecom, and energy (revenue & shipments)
  - breakdown by technology including discrete, module and wafer size
  - market players supply chain, strategy and revenue analysis at device, epiwafer and wafer level.....
Dr. Taha AYARI, Technology and Market Analyst, Compound Semiconductors

Taha Ayari, Ph.D., is a Technology & Market Analyst, Compound Semiconductors and Emerging Substrates, at Yole Intelligence. As a member of the Power Electronics & Wireless division at Yole, Taha’s expertise is mainly dedicated to power, RF, and optoelectronics. He is fully engaged in the development of technology and market reports as well as custom projects.

Taha has 2 years’ experience as a Technology & Cost Analyst at Yole System Plus, part of Yole Group, where he focuses on the development of compound semiconductor reverse engineering & costing analyses.

Prior to Yole, Taha was a research engineer at Georgia Tech Lorraine (Metz, France). He published numerous papers with a particular focus on III-N materials.

Taha holds an M.Sc. and a Ph.D. in Electrical and Computer Engineering from the Georgia Institute of Technology (Atlanta, USA).

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