Blog

650 V GaN FETs – from invention to industrialization

As Nexperia launches its first 650 V GaN-on-Si FETs, we take a quick look at how this technology has progressed from invention to industrialization. From initial investigations into the potential of GaN almost ten years ago to overcoming GaN-on-Si challenges and now being in production today. We believe our technology is ready to deliver the power conversion efficiency and power density critical to automotive and IoT developments.

As any researcher or technology developer will tell you, getting a new technology out of the lab and into full-scale volume production can easily take a decade or more. That has clearly been the case with Gallium Nitride (GaN) FETs. While this III-V direct bandgap semiconducting material has been widely used in light-emitting diodes (LEDs) since the 1990s, it has not had an easy journey into mainstream power transistor use.

At Nexperia we first started investigating the potential of GaN almost ten years ago, when we were still part of NXP. As well as its use in optoelectronics, this mechanically stable compound semiconductor offers a number of significant performance benefits for both high-frequency and high-power devices. Not only can it easily handle much higher voltages than bulk silicon, it also offers high heat capacity and thermal conductivity. So, in many ways, it is the ideal technology for 650 V high-power FETs.

Overcoming GaN-on-Si challenges

Of course, there have been a number of challenges to overcome before GaN could be considered for mainstream high-power FET use. Firstly, from a manufacturing perspective III-V semiconductors tend to be costly to process. Being able to successfully grow thick GaN epitaxial layers on large silicon substrates with the right epi-performance was key to enabling standard 150 mm (6 inch) fabs to be used for primary production. This delivers the scalability and cost-down metrics needed for true volume production.

From a FET device perspective, addressing issues such as dynamic R_{DSon} was critical to achieving the device performance that customers need. The result is a substantially lower switching figure of merit (R_{DSon} x Q_{qd}) and reverse recovery charge (Q_{rr}), which enable high switching frequencies while delivering lower dissipation and more efficient power conversion.

Naturally, for volume production each and every device needs to reliably deliver on its promise. So at Nexperia we have drawn on our experience of pushing Automotive MOSFET testing beyond two-times AEC-Q101 requirements on key reliability tests. That has meant spending a lot of time repeatedly testing our GaN devices to ensure they deliver reliably throughout their lifetime.

Finally understanding the true benefit of GaN-on-Si FETs from an application / topology perspective has been vital. Nexperia has been able to characterise functional devices and understand how they behave in various topologies. This has allowed us to build the understanding and in-house experience to support customers and enable GaN to become a mainstream power semiconductor technology.

An ideal time for 650 V GaN FETs

The release of Nexperia's first 650 V GaN FETs neatly fits with the increasing demand for high-power FETs. Our first devices will already provide a performance and efficiency boost for the high-end power supplies needed to deliver the reduced power losses in industrial automation, data centres, and telecommunications infrastructure. And as we continue the development towards automotive qualified devices, including surface-mount versions, the ongoing electrification of the powertrain will be boosted by the greater power density and efficiency offered by GaN-on-Si FETs.

At last GaN is completing its journey from invention to industrialization and starting to realize its potential as a mainstream power transistor technology.

For samples please contact your local Nexperia representative

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