FABS and LABS

NXP's 150 mm GaN Wafer Fab — Most Advanced RF GaN Fab in the US

NXP, the world's largest supplier of LDMOS power transistors for cellular infrastructure, has built and qualified a 150 mm wafer fab to produce its GaN on SiC power transistors. The $ 100 million investment in a dedicated GaN wafer fab in Chandler, Arizona, reflects NXP's belief in GaN's market potential in 5G.

GaN is not a new technology to NXP. Motorola—which became Freescale Semiconductor in 2004 and then merged with NXP Semiconductors in 2015—began researching GaN as an RF semiconductor technology nearly 20 years ago, when only 2-in. wafers were available. As the technology matured, the company transferred its GaN process to a foundry partner to serve its nascent production needs, with initial products shipping in 2014.

While LDMOS has been the dominant base station power transistor technology for three decades, GaN adherents have long argued its potential to eventually supplant LDMOS: higher power density and efficiency, higher frequency coverage and wider bandwidth. Like any new technology, GaN faced the challenges of demonstrating these performance advantages in producible, reliable devices and reducing manufacturing cost to meet the expectations of base station equipment manufacturers. The launch of 5G, with its higher frequency bands, wider channel bandwidths, massive MIMO architectures and need to minimize energy consumption shifted the power amplifier trade space enough to give GaN a beachhead, leading to widespread adoption.

With its power transistor heritage rooted in the base station market, NXP focused its GaN development on the performance needs of the base station, especially linearity. In contrast, the U.S. GaN device industry focused on maximizing power and efficiency, driven by radar and electronic warfare applications. This led to devices with "memory" effects caused by electron trapping, which makes the device harder to linearize with digital predistortion (DPD). NXP's development treated linearity as co-equal with power and efficiency, yielding a material structure and device that is "DPD friendly."

The decision to build its own GaN fab gives NXP more control over production capacity and cost, with tighter integration between the process and device designers—both in Chandler. Nonetheless, it will retain its external GaN foundry to ensure sufficient capacity as 5G volumes ramp, as well as redundancy in its supply chain. NXP's GaN products will be assembled and tested at its facility in Malaysia, which also serves as the back-end for LDMOS.

Built within an existing building in Chandler, the fab was a "greenfield" construction using the traditional bay/chase design: the operators work in the bays, i.e., the clean room, and the back of the equipment and electrical and plumbing connections are in the chase. The fab, NXP's sixth, uses best practices from its silicon fabs: automation, SPC and machine learning. However, unlike silicon, SiC wafers are optically transparent, which posed a challenge requiring unique wafer handling and processing.

On September 29, NXP virtually cut the ribbon at the fab and plans for it to be at full capacity, shipping product by the end of the year. NXP's $ 100 million investment should eliminate any lingering doubts about GaN's future in the base station market. However, NXP's commitment to GaN does not mean it is retiring LDMOS. Rather, its strategy is to offer a full suite of technologies for wireless infrastructure: LDMOS, GaN and SiGe for mmWave applications.

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